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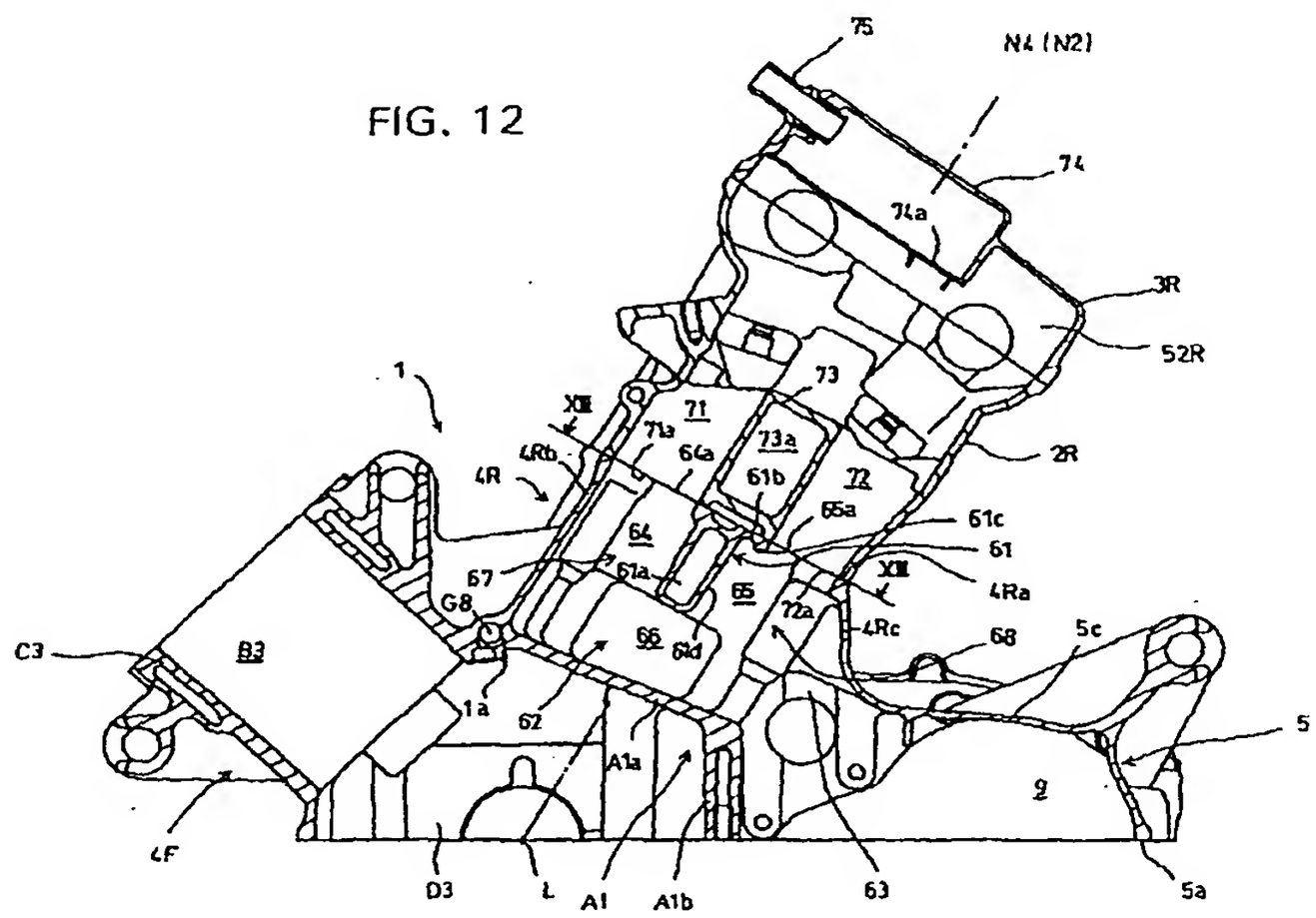
(54) V-type internal combustion engine

(57) The invention provides a V-type internal combustion engine capable of forming a breather path having a sufficiently large flow path area without enlarging a cylinder block.

A 5-cylinder V-type internal combustion engine includes a breather apparatus, a crankshaft having three crankpins and a cylinder block (1) formed with a front bank (4F) of three cylinders and a rear bank (4R) of two cylinders. Each of two crankpins disposed at both ends is connected with both of two connecting rods connected to pistons fitted to cylinder bores formed in the front and the rear banks (4F and 4R), a crankpin disposed at a middle is connected only with a connecting rod connected to a piston fitted to a cylinder bore (B3) formed at a middle of the front bank (4F) and in the rear bank (4R), a breather path (67) of a breather apparatus is formed at a space portion (60) between the two cylinder bores at a position opposed to the cylinder bore (B3) at the middle.

FIG. 12



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Descripti n

[0001] The present invention relates to a V-type internal combustion engine having a breather apparatus for recirculating blowby gas from a crankcase to an intake system, in details, relates to arrangement of a breather path constituting the breather apparatus.

[0002] Conventionally, there is a V-type internal combustion engine having a breather apparatus for recirculating blowby gas to an intake system disclosed in Japanese Utility Model Publication No. 7209/1989. The breather apparatus is provided with a breather chamber provided at a bottom wall portion of a V-bank, a hole communicating a crankcase with the breather chamber and a communication path formed at a cylinder wall of a cylinder block for communicating the breather chamber and a valve operating chamber communicating with an intake manifold and blowby gas from the crankcase is recirculated to the intake manifold via the breather chamber, the communication path and the valve operating chamber.

[0003] Meanwhile, according to the conventional breather apparatus, the communication path which is also a breather path for flowing blowby gas, is formed at the cylinder wall on an inner side of the V-bank and therefore, a flow path area of the communication path is limited, in order to ensure a sufficient flow path area, a plurality of communication paths are formed, or in order to increase the flow path area of the communication path, it is necessary to significantly bulge the cylinder wall formed with the communication path to the inner side of the V-bank and therefore, there is a difficulty in which a width of the bank formed with the communication path is increased in a direction orthogonal to a direction of arranging cylinders, the cylinder block is large-sized, arrangement of an intake apparatus arranged in a space formed by the V-bank is restricted and the internal combustion engine is large-sized.

[0004] The present invention has been carried out in view of such a situation and it is an object thereof to provide a V-type internal combustion engine capable of forming a breather path having a sufficiently large flow path area without enlarging a cylinder block.

[0005] According to the invention of the application described in Claim 1, there is provided a V-type internal combustion engine characterized in that in a V-type internal combustion engine including a breather apparatus for recirculating blowby gas from a crankcase to an intake system, a crankshaft having three or more of crankpins including a first, a second and a third crankpin contiguous to each other in a direction of a rotational axis line and a cylinder block formed with a first and a second bank forming a V-like shape, the first and the third crankpins are respectively connected with a first and a third connecting rod respectively connected to a first and a third piston respectively fitted to a first and a third cylinder bore formed at the first bank, the second crankpin disposed between the first and the third crankpins, is connected only with a second connecting rod connected to a second piston fitted to a second cylinder bore formed at the second bank and the breather apparatus includes a breather path formed at a space portion between the first and the third cylinder bores in the first bank.

[0006] According to the invention described in Claim 1, in the first bank, the space portion formed between the first and the third cylinder bores constituting a position opposed to the second cylinder bore of the second bank, is provided with a width in the direction of the rotational axis line to a degree slightly smaller than a diameter of the second cylinder bore at minimum and therefore, a flow path area of the breather path formed at the space portion can sufficiently be increased without increasing a width of the first bank in the direction of the rotational axis line and a width in a direction orthogonal to an assumed plane including the rotational axis line and a center line of the first cylinder bore or the third cylinder bore and accordingly, without increasing a width of the cylinder block in the direction of the rotational axis line.

[0007] As a result, the following effect is achieved. That is, in the first bank, the breather path is formed at the space portion having the width in the direction of the rotational axis line to the degree slightly smaller than the diameter of the second cylinder bore at minimum and therefore, there is provided the breather path having the sufficiently large flow path area without enlarging the first bank in the direction of the rotational axis line and in the direction orthogonal to the assumed plane and accordingly, without enlarging the cylinder block and after reducing the weight of the cylinder block. Further, by increasing the flow path area of the breather path, a flow rate of blowby gas flowing the breather path can be restrained to be low and therefore, an effect of separating lubricating oil mist mixed in the blowby gas is expedited.

[0008] According to the invention described in Claim 2, there is provided a V-type internal combustion engine characterized in that in a V-type internal combustion engine of an odd number of cylinders including a breather apparatus for recirculating blowby gas from a crankcase to an intake system, a crankshaft having a plurality of crankpins including a first and a second crankpin contiguous to each other in a direction of a rotational axis line and a cylinder block formed with a first bank having an odd number of cylinders and a second bank having an even number of cylinders forming a V-like shape, the first crankpin is connected with both of a first and a second connecting rod respectively connected to a first and a second piston respectively fitted to a first and a second cylinder bore respectively formed at the first and the second banks, the second crankpin is connected only with a third connecting rod connected to a third piston fitted to a third cylinder bore formed at a bank in the first and the second banks having a larger number of the cylinders and the breather apparatus includes a breather path formed at a space portion contiguous to a side the

same as a side at which the second crankpin is contiguous to the first crankpin relative to the first cylinder bore or the second cylinder bore in a bank of the first and the second banks having a smaller number of the cylinders.

[0009] According to the invention described in Claim 2, in the bank having the smaller number of the cylinders of the V-type internal combustion engine of the odd number of the cylinders, the space portion contiguous to the first cylinder bore or the second cylinder bore disposed at a position opposed to the third cylinder bore of the bank having the larger number of the cylinders, is provided with a width in the direction of the rotational axis line to a degree slightly smaller than a diameter of the third cylinder bore within a range of not projected to the bank having the larger number of the cylinders in the direction of the rotational axis line and a flow path area of the breather path formed at the space portion can sufficiently be increased without increasing a width of the bank having the smaller number of the cylinders in a direction orthogonal to an assumed plane including the rotational axis line and a center line of the first cylinder bore or the second cylinder bore and accordingly, without increasing a width of the cylinder block in the direction of the rotational axis line, the width in the direction of the rotational axis line being reduced by coupling the two connecting rods to the first crankpin.

[0010] As a result, the following effect is achieved. That is, in the bank having the smaller number of the cylinders, the breather path is formed at the space portion having the width in the direction of the rotational axis line to the degree slightly smaller than the diameter of the third cylinder bore within the width in the direction of the rotational axis line of the bank having the larger number of the cylinders and therefore, the breather path having the sufficiently large flow path area is provided without enlarging the bank having the smaller number of the cylinders in the direction orthogonal to the assumed plane including the rotational axis line and the center line of the cylinder bore and accordingly, without deteriorating an advantage of the cylinder block downsized by coupling the two connecting rods to the first crankpin. Further, by increasing the flow path area of the breather path, a flow rate of blowby gas flowing in the breather path can be restrained to be low and therefore, an effect of separating lubricating oil mist mixed in the blowby gas is expedited.

[0011] According to the invention described in Claim 3, there is provided the V-type internal combustion engine according to Claim 2, characterized in that the crankshaft includes a third crankpin contiguous to a side opposed to the side at which the first crankpin is contiguous to the second crankpin, wherein the third crankpin is connected with both of a fourth and a fifth connecting rod respectively connected to a fourth and a fifth piston respectively connected to a fourth and fifth cylinder bore respectively formed at the first and the second banks and the space portion is present between the first and the fourth cylinder bores or between the second and the fifth cylinder bores.

[0012] According to the invention described in Claim 3, in the bank having the smaller number of the cylinders, the space portion formed between the first and the fourth cylinder bores or between the second and the fifth cylinder bores, is provided with the width in the direction of the rotational axis line to the degree slightly smaller than the diameter of the third cylinder bore at minimum within the range of the width of the bank having the larger number of the cylinders in the direction of the rotational axis line and therefore, the flow path area of the breather path formed at the space portion can sufficiently be increased without increasing the width of the bank having the smaller number of the cylinders in the direction of the rotational axis line and accordingly, without increasing the width of the cylinder block in the direction of the rotational axis line, the width in the direction of the rotational axis line being reduced by coupling the two connecting rods to each of the first and the third crankpins.

[0013] As a result, the following effect is achieved in addition to the effect of the invention described in Claim 2. That is, the breather path having the sufficiently large flow path area is provided without enlarging the bank having the smaller number of the cylinders in the direction of the rotational axis line and accordingly, without deteriorating the advantage of the cylinder block downsized by coupling the two connecting rods to each of the first and the third crankpins, further, after reducing the weight of the cylinder block.

[0014] According to the invention described in Claim 4, in the V-type internal combustion engine according to any one of Claim 1 through Claim 3, the space portion is formed with a return oil path of lubricating oil and a partition wall is provided between the breather path and the return oil path for partitioning such that the breather path and the return oil path are in parallel with each other in the direction of the rotational axis line.

[0015] According to the invention described in Claim 4, the space portion is provided with the width in the direction of the rotational axis line to the degree slightly smaller than the diameter of the cylinder bore within the range of not projected to the bank having the larger number of the cylinders in the direction of the rotational axis line at minimum, the return oil path of the lubricating oil having a sufficiently large flow path area can be formed other than the breather path having a sufficient blow path area without enlarging the cylinder block and the blowby gas and the lubricating oil can be restrained from mixing together by the partition wall partitioning the breather path and the return oil path to be in parallel with each other in the direction of the rotational axis line.

[0016] As a result, the following effect is achieved in addition to the effect of the invention described in the cited claims. That is, the breather path and the return oil path are formed at the space portion having the width in the direction of the rotational axis line to the degree slightly smaller than the diameter of the cylinder bore

within a range of not projecting in the direction of the rotational axis line at minimum or relative to the bank having the larger number of the cylinders and accordingly, the return oil path having the sufficient flow path area is provided along with the breather path without enlarging the cylinder block the lubricating oil returns smoothly and further, the blowby gas and the lubricating oil can be restrained from mixing together by the partition wall and an amount of the lubricating oil mist mixed into the blowby gas can be reduced also with this regard.

[0017] Preferred embodiments of the present invention will be described hereinafter with reference to the accompanying drawings, in which:

Fig. 1 is a right side view of a V-type internal combustion engine to which the invention is applied.

Fig. 2 is a sectional view substantially taken along a line II-II of Fig. 1.

Fig. 3 is a plane view of a cylinder block of Fig. 1.

Fig. 4 is a right side view of the cylinder block and a lower crankcase of Fig. 1.

Fig. 5 is a sectional view of the cylinder block and the lower crankcase taken along a line V-V of Fig. 3.

Fig. 6 is a sectional view taken along a line VI-VI of Fig. 5.

Fig. 7 is a sectional view taken along a line VII-VII of Fig. 4.

Fig. 8 is a front view of the lower crankcase viewed in an arrow mark VIII of Fig. 4.

Fig. 9 is a sectional view taken along a line IX-IX of Fig. 8.

Fig. 10 is a sectional view taken along a line X-X of Fig. 4.

Fig. 11 is a bottom view of the cylinder block.

Fig. 12 is a view taken along a line XII-XII of Fig. 3.

Fig. 13 is an end face view of a rear bank of the cylinder block in a direction XIII of Fig. 12.

Fig. 14 is a bottom view of a rear cylinder head.

[0018] An explanation will be given of embodiments of the invention in reference to Fig. 1 through Fig. 14 as follows.

[0019] In reference to Fig. 1 through Fig. 5, a V-type internal combustion engine E to which the invention is applied, is a V-type 5-cylinder 4-cycle internal combustion engine of a DOHC type and a water-cooled type constituting a power apparatus mounted to a motorcycle along with a transmission apparatus for transmitting the power to rear wheels. As illustrated in Fig. 1, the internal combustion engine E is provided with, in a front and rear direction, a cylinder block 1 having a front bank 4F and a rear bank 4R forming a V-bank in a V-like shape having an angle of substantially 75°, a front cylinder head 2F and a rear cylinder head 2R fastened to upper end faces 4Fa and 4Ra of the cylinder block 1 at the respective banks 4F and 4R, and a front head cover 3F and a rear head cover 3R respectively fastened to the two cylinder heads 2F and 2R. Further, according to the cylinder block 1, a lower portion thereof is formed with an upper crankcase 5 and an upper portion thereof is formed with the two banks 4F and 4R, respectively and a lower end face 5a of the upper crankcase 5 is matched with an upper end face 6a of a lower crankcase 6 to thereby fasten the cylinder block 1 and the lower crankcase 6. Further, a crankshaft 7 transversely arranged to direct a left and right direction of a vehicle body, is rotatably supported by the crankcase constituted by the upper crankcase 5 and the lower crankcase 6 in a state in which a rotational axis line L thereof is disposed on a match face of the lower end face 5a of the upper crankcase 5 and the upper end face 6a of the lower crankcase 6. Further, in the specification, "front, rear, left, right" signifies "front, rear, left, right" with the vehicle body as a reference.

[0020] Further, in reference to Fig. 5, by a front portion of the upper crankcase 5 and a front portion of the lower crankcase 6, the crankcase 8 containing the crankshaft 7 is formed, and by a rear portion of the upper crankcase 5 and a rear portion of the lower crankcase 6, there is formed a transmission chamber 9 containing a wet type multi-plate friction clutch (not illustrated) and a gear transmission M of an always in-mesh type constituting a transmission apparatus. The lower end face 6b of the lower crankcase 6 is matched with an upper end face 10a of an oil pan 10 in oil tight to thereby fasten the oil pan 10.

[0021] Further, the crankcase 8 and the transmission chamber 9 are separated by a bearing portion D1 constituting a left side wall and a bearing portion D4 constituting a right side wall (refer to Fig. 2) constituting two side walls of the cylinder block 1 and the lower crankcase 6, and separated by a partition wall comprising an upper partition wall A1 formed at the cylinder block 1 and a lower partition wall A2 formed at the lower crankcase 6 to thereby constitute chambers independent from each other, thereby, the crankcase 8 is hermetically closed.

[0022] Also in reference to Fig. 2, the front bank 4F is provided with three cylinders C1, C3 and C5 aligned in the direction of the rotational axis line L of the crankshaft 7 and integrally coupled and center lines N1, N3 and N5 of the cylinder bores B1, B3 and B5 formed at the respective cylinders C1, C3 and C5, are directed from the

rotational axis line L in skewed front upper directions and the respective cylinders C1, C3 and C5 are inclined forwardly. Further, the rear bank 4R is provided with two cylinders C2 and C4 aligned along the direction of the rotational axis line L and integrally coupled and center lines N2 and N4 of cylinder bores B2 and B4 formed at the respective cylinders C2 and C4 are directed from the rotational axis line L in skewed rear upper directions and the respective cylinders C2 and C4 are inclined rearwardly. Pistons P1 through P5 are slidably fitted to the cylinder bores B1 through B5 of the respective cylinders C1 through C5 and the pistons P1 through P5 reciprocating by combustion pressure of combustion chambers formed between the respective pistons P1 through P5 and the cylinder heads 2F and 2R, drive to rotate the crankshaft 7 via connecting rods R1 through R5 connecting the respective pistons P1 through P5 and the crankshaft 7.

[0023] Specifically, the crankshaft 7 is supported by the cylinder block 1 and the lower crankcase 6 by four bearing portions D1 through D4 respectively formed in the direction of the rotational axis line L at predetermined intervals at journals J1 through J4 via main bearings 11. Further, the crankcase 8 is partitioned into three chambers in the direction of the rotational axis line L with the two bearing portions D1 and D4 as both ends by the two bearing portions D2 and D3 disposed at its middle.

[0024] In the crankshaft 7, a crankpin K1 between the bearing portion D1 and the bearing portion D2, is connected with both of the connecting rods R1 and R2 connected to piston pins S1 and S2 of the two pistons P1 and P2, a crankpin K2 disposed between the bearing portion D2 and the bearing portion D3 and contiguous to the crankpin K1, is connected only with the connecting rod R3 connected to a piston pin S3 of the piston P3 and a crankpin K3 disposed between the bearing portion D3 and the bearing portion D4 and contiguous to the crankpin K2, is connected with both of the connecting rods R4 and R5 connected to a fourth and a fifth piston pin S4 and S5 of the two pistons P4 and P5.

[0025] In reference to Fig. 1, the respective cylinder heads 2F and 2R are formed with an intake port 12 having a pair of inlet ports opened to the combustion chamber and an exhaust port 13 having a pair of outlet ports and is provided with a pair of intake valves 14 respectively opening and closing the pair of inlet ports and a pair of exhaust valves 15 for opening and closing the pair of outlet ports and provided with an ignition plug T facing inside of the respective combustion chamber, at the respective combustion chamber. Further, in the front cylinder head 2F, an intake cam shaft 16 and an exhaust cam shaft 17 are rotatably supported by four cam holders arranged at intervals in the direction of the rotational axis line L and in the rear cylinder head 2R, the intake cam shaft 16 and the exhaust cam shaft 17 are rotatably supported by three cam holders arranged at intervals in the direction of the rotational axis line L. Further, two sets of the two cam shafts 16 and 17 are respectively driven to rotate at a rotational number of 1/2 of that of the crankshaft 7 by power of the crankshaft 7 transmitted from an intermediate gear 19 in mesh with the drive gear 18 provided at a right end portion of the crankshaft 7 via a front side timing gear train 20 and a rear side timing gear train 21 and drive the respective intake valves 14 and the respective exhaust valves 15 at predetermined timings.

[0026] Further, an intake apparatus connected to the respective intake ports 12, is arranged on the inner side of the V-bank and an exhaust pipe connected to the exhaust ports 13 of the cylinders C1, C3 and C5 of the front bank 4F, is extended in the rear direction by passing through a space formed to recess at the right side of the lower portion of the left wall of the oil pan 10.

[0027] Further, as illustrated in Fig. 2, the drive gear 18 and the intermediate gears 19 disposed on the right side of the cylinder block 1 and the two cylinder heads 2F and 2R, are covered by a cover 22 attached to right side walls of the upper crankcase 5 and the lower crankcase 6 and two timing gear trains 20 and 21 are arranged in a cavity Y formed at right end portions of the two banks 4F and 4R of the cylinder block 1 and the two cylinder heads 2F and 2R. Therefore, the drive gear 18, the intermediate gears 19 and the two timing gear trains 20 and 21 are contained in a gear chamber 23 constituted by a space formed by the right side walls and the cover 22 and the cavity Y and the gear chamber 23 is communicated with the oil pan 10 via a cavity formed at the lower crankcase 6 formed therebelow (not illustrated). Further, an alternator 24 is provided at a left end portion of the crankshaft 7.

[0028] In reference to Fig. 1, the power of the crankshaft 7 is transmitted to the multi-plate friction clutch via a primary speed reducing mechanism comprising a primary drive gear 25 and a primary driven gear 26 and is transmitted further to the gear transmission M. A main shaft 27 and a counter shaft 28 of the gear transmission M are respectively provided with a main gear group and a counter gear group, not illustrated, and when a shift drum 29 is rotated by a speed change operating mechanism, shift forks engaged with cam grooves of the shift drum 29 are pertinently moved in the left and right direction on a support shaft 30, gears of the main gear group and the gears of the counter gear group in correspondence with the speed change operation are pertinently brought in mesh with each other, the power of the crankshaft 7 is subjected to speed change and is transmitted from the main shaft 27 to the counter shaft 28 and power of the counter shaft 28 is transmitted to rear wheels via a secondary speed reducing mechanism having a chain (not illustrated).

[0029] Further, the power of the crankshaft 7 is transmitted to a pump gear 32 provided at a drive shaft 33 of an oil pump unit U via an intermediate gear 31b in mesh with a pump drive gear 31a rotated integrally with the primary driven gear 26 rotatably supported by the main shaft 27, then the oil pump unit U is driven. Further, the

left end of the drive shaft 33 is coupled with a rotating shaft provided with an impeller of cooling water pump, not illustrated.

[0030] An explanation will be given here of a lubricating system of the power apparatus. In the oil pan 10, an oil strainer 34 is arranged and an oil pipe 35 extended from the oil strainer 34 in the upper direction is connected to a fourth intake port of a feed pump 36 of the oil pump unit U. In reference to Fig. 5 and Fig. 6, the oil pump unit U is provided with a first scavenge pump 37, the feed pump 36, a second scavenge pump 38 and a third scavenge pump 39 in the axial direction of the drive shaft 33 successively from right and the pumps 36 through 39 are constituted by trochoid pumps. The oil pump unit U is provided with a first intake port 37a of the first scavenge pump 37, a second intake port 38a of the second scavenge pump 38, a third intake port 39a of the third scavenge pump 39 and a single one of a first delivery port 40 communicating with respective delivery ports (not illustrated) of the first through the third scavenge pumps 37 through 39 and further provided with the fourth input port 36a of the feed pump 36 and a relief port 36b provided with a relief valve and a second delivery port 36c. The first delivery port 40 is provided at a vicinity of the second scavenge pump 38 in the axial direction of the drive shaft 33 and directed substantially to the main shaft 27 of the gear transmission M.

[0031] In reference to Fig. 5, the lower crankcase 6 is provided with an inclined partition wall A2a extended from a front portion of a lower end face 6b coupled with the oil pan 10 in a skewed rear upper direction and constituting an acute angle between the inclined partition wall A2a and a flat wall portion 6c2, mentioned later, of a front wall 6c of the lower crankcase 6 and the oil pump unit U is attached to an attaching face formed on the side of the oil pan 10 of the inclined partition wall A2a constituting a portion of the lower partition wall A2. In a state in which the oil pump unit U is attached to the attaching face, as illustrated in Fig. 7, the inclined partition wall A2a is provided with a first, a second and a third intake port 41, 42 and 43 respectively connected to the first, the second and the third input ports 37a, 38a and 39a. Further, lubricating oil which is supplied into the crankcase 8, finished lubricating necessary lubricating portions and flows down to the bottom portion of the crankcase 8, is sucked respectively from the first through the third intake ports 41 through 43 to the first through the third scavenge pumps 37 through 39 and discharged from the first delivery port 40 into the transmission chamber 9.

[0032] Further, as illustrated in Fig. 8 and Fig. 9, in the inclined partition wall A2a, at a position slightly upward from the lower end face 6b, there is provided an oil path G1 connected to the second delivery port 36c by coupling with an end face of the second delivery port 36c, and the oil path G1 is connected to an oil path G2 constituting an introducing oil path G4, mentioned later, for conducting the lubricating oil to an oil filter 44 for cleaning the lubricating oil by removing foreign matters in the lubricating oil by a filter element 44a. In reference to Fig. 5 and Fig. 8, the oil filter 44 in a cylindrical shape is attached to an attaching sheet 45 formed at the front wall 6c of the lower crankcase 6. Specifically, the front wall 6c is provided with a partially cylindrical curved wall portion 6c1 constituting a portion in a peripheral direction of a substantially cylindrical peripheral wall with the rotational axis line L as a center line and the flat wall portion 6c2 substantially in a flat plate shape continuous to a lower end portion 6c1a of the curved wall portion 6c1 disposed substantially right below the rotational axis line L and extended in a vertical lower direction to reach a lower end face 6b. A portion of the lower end face 6b in correspondence with the flat wall portion 6c2 is matched to the upper end face 10a at the front wall 10b portion in the flat plate shape of the oil pan 10.

[0033] The attaching seat 45 is in a mode formed by projecting from front faces of the curved wall portion 6c1 and the flat wall portion 6c2 in a space formed by the curved wall portion 6c1 and the flat wall portion 6c2 and an attaching face 45a attached with the oil filter 44, is disposed upward from the lower end face 6b, disposed rearward from a contact portion 6c3 of the front face in contact with an assumed plane H in contact with a frontmost portion of the lower end face 6b and a front face of the curved wall portion 6c1 and formed at a position slightly projected forward from the assumed plane H and substantially along the assumed plane H. Also in reference to Fig. 10, inside of the attaching seat 45 is formed with an oil path G3 comprising a groove in a ring-like shape opened to the attaching face 45a and the oil path G2 one end of which is connected to the oil path G1 and other end of which is connected to a lower portion of the oil path G3 from a tangential direction of the oil path G3, an introducing oil path G4 is constituted by the oil path G2 and the oil path G3 and the lubricating oil delivered from the feed pump 36 flows into the oil filter 44 via the introducing oil path G4.

[0034] Further, at a central portion of a circular ring of the oil path G3 in the ring-like shape, there is formed a screw hole 46 cut with a female screw in a direction orthogonal to the attaching face 45a and the screw hole 46 is screwed with a screw portion 44b in a cylindrical shape for forming an oil path at its inside of the oil filter 44. Further, there is formed an introducing oil path G5 opened to a peripheral wall at a vicinity of a bottom portion of the screw hole 46 and extended substantially in parallel with the rotational axis line L and accordingly, the lower end portion 6c1a of the curved wall portion 6c1 and to the right side of the screw hole 46 at a vicinity of the lower end portion 6c1a.

[0035] In reference to Fig. 4 and Fig. 10, the introducing oil path G5 is connected to an oil path G6 formed at the front wall 6c and opened to the upper end face 6a at the right end portion of the lower crankcase 6 and the oil path G6 is connected to one end of an oil path G7 formed at the right end portion of the cylinder block 1

and other end of the oil path G7 is connected to a main gallery G8 formed at a bottom wall portion 1a of the V-bank of the cylinder block 1 at the upper end face 6a. The main gallery G8 is extended from a right end portion of the bottom wall portion 1a substantially in parallel with the rotational axis line L, opened at a left end face of the cylinder block 1 (refer to Fig. 3), as illustrated in Fig. 2, connected to an oil path G9 formed at an alternator cover 37 fastened to a left end face of the crankshaft 7 and the oil path G9 is connected to an oil path G11 formed by utilizing a screw hole screwed with a bolt 48 of the crankshaft 7 via an oil path G10 formed at inside of the bolt 48 for fixing a rotor of the alternator 24 to the crankshaft 7. Further, the oil path G11 is connected with one end of an in-shaft oil path G12 formed at inside of the crankshaft 7 and other end of the in-shaft oil path G12 is connected to an oil path G13 formed by utilizing a screw hole screwed with a bolt 49 for fixing a ring for hampering movement of the drive gear 18 in the direction of the rotational axis line L at the right end portion of the crankshaft 7 and the oil path G13 is connected to an oil path G16 provided at the cover 22 via an oil path G14 formed at inside of the bolt 49 and an oil path G15 formed at a cap 50 mounted to the cover 22. The lubricating oil which has passed through the oil path G16 is injected from a nozzle 51 provided at other end of the oil path G16 toward the intermediate gears 19, the drive gear 18 and the two timing gear trains 20 and 21.

[0036] Further, the first through the third crankpins K1 through K3 are formed, in the diameter direction, with oil paths G17 connected to the in-shaft oil path G12 for supplying the lubricating oil to the connecting portions of the respective crankpins K1 through K3 connected with the connecting rods R1 through R5 and the journals J2 and J3 are formed, in the diameter direction, with oil paths G18 connected to the in-shaft oil path G12 for supplying the lubricating oil to the bearing portions D2 and D3. Further, the journals J1 and J4 are formed, in the diameter direction, oil paths G19 respectively connected to the oil path G11 and the oil path G13 for supplying the lubricating oil to the two bearing portions D1 and D4.

[0037] Further, in reference to Fig. 3 and Fig. 4, in the main gallery G8, at a portion thereof connected with the oil path G7, there are formed head oil paths G20 and G21 extended from the connected portion to the cylinder heads 2F and 2R of the respective banks 4R and 4F in the cylinder block 1, by way of the respective head oil paths G20 and G21, the lubricating oil is supplied to a front valve operating apparatus VF constituted by the two cam shafts 16 and 17, lifters and the like arranged at inside of a front valve operating chamber 52F formed by the front cylinder head 2F and the front head cover 3F, and a rear valve operating chamber VR constituted by the two cam shafts 16 and 17, lifters and the like arranged at inside of a rear valve operating chamber 52R formed by the rear cylinder head 2R and the rear head cover 3R (refer to Fig. 1). That is, the respective head oil paths G20 and G21 are connected to oil paths formed at cam holders fixed to the respective cylinder heads 2F and 2R and disposed at right ends thereof at upper end faces 4Fa and 4Ra and the respective valve operating apparatus VF and FR are lubricated by lubricating oil supplied from the cam holders to hollow portions of the two cam shafts 16 and 17 and supplied from oil holes provided at necessary portions of the two cam shafts 16 and 17.

[0038] Further, in reference to Fig. 4 and Fig. 11, at the main gallery G8, contiguous to the right side of the cylinder C2 of the rear bank 4R, an oil path G22 opened to the lower end face 5a of the cylinder block 1 (lower crankcase 5), is formed to branch, by way of an oil path 23 comprising a groove formed at the lower end face 5a of the cylinder block 1 and an oil path G24 comprising a groove formed at the upper end face 6a of the lower crankcase 6a, passing an oil path G25 and an oil path G26 formed at the lower crankcase 6, the lubricating oil is supplied to the sliding portions of the main shaft 27 and the support shaft 30 of the gear transmission M.

[0039] Further, in reference to Fig. 5 and Fig. 11, along the main gallery G8, at an inner face of the bottom wall portion 1a of the cylinder block 1, there are provided five mounting portions 53 mounted with nozzles 54 (refer to Fig. 5) in correspondence with the respective cylinder bores B1 through B5 at portions including the center lines N1 through N5 of the respective cylinder bores B1 through B5 and intersected with assumed planes orthogonal to the rotational axis line L, and by injecting the lubricating oil which has passed through oil paths G27 provided at the respective mounting portions 53 and connected to the main gallery G8 from the nozzles 54, the lubricating oil is supplied to the connecting portions of the respective pistons S1 through S5 and the respective connecting rods R1 through R5 and sliding portions of the respective cylinders C1 through C5 and the respective pistons P1 through P5.

[0040] Next, an explanation will be given of a return oil path of the lubricating oil and a breather apparatus.

[0041] First, with regard to the front bank 4F, in reference to Fig. 3 and Fig. 11, at the front wall of the cylinder head 2F, at a left side portion of the cylinder C1, that is, the left end portion of the front bank 4F, between the two cylinders C1 and C3 and between the two cylinders C3 and C5, there are formed a first, a second and a third return oil path 55, 56 and 57 of the lubricating oil respectively having opening portions 55a, 56a and 57a at the upper end face 4Fa of the cylinder block 1, further, there are formed oil paths connected to the respective opening portions 55a, 56a and 57a to open to inside of the front valve operating chamber 52F, the lubricating oil which has finished lubricating the front valve operating apparatus VF is gathered at the lower portion of the cylinder block 1 by way of the first through the third return oil paths 55 through 57 formed at the front wall of the cylinder block 1, passes through a return oil pipe 58 (refer to Fig. 1) connected thereto at the lower end face 5a of the cylinder block 1 and returns to the oil pan 10 by

way of an oil path 59 (refer to Fig. 7) having an opening portion 59a (refer to Fig. 8) provided below the flat wall portion 6c2 of the front wall 6c of the lower crankcase 6.

[0042] Meanwhile, in reference to Fig. 12 and Fig. 13, in the rear bank 4R, substantially in the front and rear direction, that is, in a direction orthogonal to an assumed plane including the rotational axis line L and dividing the V-bank in two, at a position opposed to the cylinder bore B3 of the front bank 4F, between the cylinder bore B2 and the cylinder bore B4 in the direction of the rotational axis line L, there is formed a space portion 60 having a width in the direction of the rotational axis line L to a degree slightly smaller than the diameter of the cylinder bore B3 and substantially equal to an interval in the direction of the rotational axis line L between a central point of the journal J2 and a central point of the journal J3 in the direction of the rotational axis line L, as a result, as illustrated in Fig. 3, the space portions 60 is within a range not projected relative to the front bank 4F in the direction of the rotational axis line L.

[0043] In the space portion 60, there is formed a cavity 62 having a partition wall 61 extended substantially in parallel with the direction of the rotational axis line L and continuous to an outer peripheral wall C2a of the cylinder C2 and an outer peripheral wall C4a of the cylinder C4. The cavity 62 is formed between an inclined partition wall A1a constituting a portion of the upper partition wall A1, extended from the bottom wall portion 1a in a skewed rear lower direction and reaching a rear end of a lower portion of the rear bank 4R and an upper end face 4Ra of the rear bank 4R, between the outer peripheral wall C2a of the cylinder C2 and the outer peripheral wall C4a of the cylinder C4 and between the inner side wall 4Rb of the V-bank of the rear bank 4R and an outer side wall 4Rc of the V-bank extended in a skewed rear lower direction and continuous to an upper wall 5C of the transmission chamber 9. Further, between a vertical partition wall A1b extended from an end portion of the inclined partition wall A1a on the side of the transmission chamber 9 in the vertical lower direction toward the lower end face 5a and constituting the upper partition wall A1 and the outer side wall 4Rc of the V-bank, there is formed an opening portion 63 for communicating the cavity 62 and the transmission chamber 9. Further, a width of the cavity 62 in the direction of the rotational axis line L is -substantially equal to an interval between the bearing portion D2 and the bearing portion D3 in the rotating shaft direction and a width thereof in a direction orthogonal to an assumed plane including the rotational axis line L and the center line N2 or the center line N4 (hereinafter, referred to as "orthogonal" direction) is substantially equal to a width of the rear bank 4R in the orthogonal direction at portions of the cylinders C2 and C4.

[0044] Above the cavity 62, there is formed a path 64 interposing the partition wall 61 extended to substantially a central portion of the upper end face 4Ra and the inclined partition wall A1a in a direction of the center line N2 or the center line N4 and having an opening portion 64a at the upper end face 4Ra on an inner side of the V-bank and there is formed a path 65 having an opening portion 65a at the upper end face 4Ra and constituting the opening portion 63 at its rear portion on an outer side of the V-bank and the paths 64 and 65 are arranged in parallel with the direction of the rotational axis line L by the partition wall 61. Further, by a path 66 formed below the partition wall 61 and below the cavity 62, the path 64 and the opening portion 63 are communicated with each other. Further, a breather path 67 of the cylinder block 1 is constituted by the opening portion 63, the path 66 and the path 64 and a oil return path 68 of the lubricating oil from the rear valve operating chamber 52R in the cylinder 1 is constituted by the path 65 and the opening portion 63.

[0045] Further, at inside of the partition wall 61, there is provided a water path 61a for communicating a cooling water jacket of the cylinder C2 and a cooling water jacket of the cylinder C4, further, at an upper portion of the partition wall 61, there are formed an eaves portion 61b extended to the outer side of the V-bank and a projected edge portion 61c constituting a front end portion of the eaves portion 61b and produced by projecting an edge portion of the opening portion 65a of the path 65 on the side of the partition wall 61 over the direction of the rotational axis line L in the lower direction. Further, the opening portion 63 constituting a flow inlet of the breather path 67 and constituting a flow outlet of the return oil path 68, are provided below the partition wall 61 and to a side more proximate to the outer side wall 4Rc of the V-bank than a side face 61d on the side of the return oil path 68 of the partition wall 61 and is disposed at a position at which a portion of the blowby gas flowed from the opening portion 63 impinges on the side face 61d and a flow elevating along the side face 61d is produced.

[0046] Further, in the rear cylinder head 2R, as illustrated in Fig. 12 and Fig. 14, there is formed a space portion 70 at a position in correspondence with the space portion 60 and there are formed a breather path 71 and a return oil path 72 of the lubricating oil having opening portions 71a and 72a having sizes respectively matching precisely with the opening portions 64a and 65a of the path 64 and the path 65 and communicating with inside of the rear valve operating chamber 52R. Further, there is formed a partition wall 73 having a lower end face matched with an upper end face of the partition wall 61 and at inside of the partition wall 73, there is formed a water path 73a for communicating a cooling water jacket formed by surrounding the combustion chamber of the cylinder C2 at the rear cylinder head 2R, the ignition plug T and a lower portion of a cylindrical portion 69 (refer to Fig. 2) containing an ignition coil and a cooling water jacket formed by surrounding the combustion chamber of the cylinder C4, the ignition plug T and a lower portion of a pipe containing an ignition coil.

[0047] Further, as illustrated in Fig. 2 and Fig. 12, at

an upper portion of the rear head cover 3R, above the breather paths 67 and 71, there is provided a breather chamber 74 having an inlet 74a opened to inside of the rear valve operating chamber 52R and a recirculating pipe (not illustrated) connected to a connection pipe 75 connected to the breather chamber 74 is connected to an intake path constituting an intake system of the internal combustion engine E.

[0048] Thereby, blowby gas in the crankcase 8 sucked by the first through the third scavenge pumps 37 through 39 along with the lubricating oil and discharged into the transmission chamber 9, flows from the transmission chamber 9 into the breather chamber 74 by passing through the breather paths 67 and 71, recirculated from the breather chamber 74 to the intake path via the recirculating pipe and is supplied to the combustion chamber. Therefore, there is constituted a breather apparatus recirculating the blowby gas from the crankcase 8 to the intake path by the first through the third intake ports 41 through 43, the first through the third scavenge pumps 37 through 39, the transmission chamber 9, the breather paths 67 and 71, the rear valve operating chamber 52R, the breather chamber 74, the connection tube 75 and the recirculating pipe.

[0049] Next, an explanation will be given of operation and effect of the embodiment constituted as described above.

[0050] When the internal combustion engine E is operated and the oil pump unit U is operated, the lubricating oil sucked from the oil pan 10 to the feed pump 36 by passing through the oil strainer 34, is delivered from the second delivery port 36c, flows into the oil filter 44 by way of the oil path G1 and the introducing oil path G4, is removed of foreign matters or the like by the oil filter 44 and is supplied to the main gallery G8 by passing through the introducing oil path G5, the oil path G6 and the oil path G7.

[0051] The lubricating oil flowed from the main gallery G8 into the in-shaft oil path G12 via the oil paths G9, G10 and G11, is supplied to the journals J1 through J4 and the crankpins K1 through K3, lubricates the respective sliding portions, and is injected from the nozzles 51, lubricates the mesh portion and the sliding portions of the drive gear 18, the intermediate gears 19 and the two timing gear trains 20 and 21, further, is injected from the nozzles 54 and lubricates the sliding portions of the respective piston pins S1 through S5 and the sliding portions of the respective pistons P1 through P5 and the respective cylinders C1 through C5. Meanwhile, the lubricating oil flowed from the main gallery G8 into the head oil paths G20 and G21, lubricates the sliding portions of the valve operating apparatus VF and VR in the respective valve operating chambers 52F and 52R.

[0052] Further, the lubricating oil which has been supplied to the crankcase 8 and finished lubricating the lubricating portions of the sliding portions and the like described above, flows down to the bottom portion of the crankcase 8 formed between the front wall 6c and the inclined partition wall A2a, sucked from the first through the third intake ports 41 through 43 to the first through the third scavenge pumps 37 through 39 and the lubricating oil delivered from the scavenge pumps 37 through 39, is discharged from the first delivery port 40 into the transmission chamber 9, lubricates the lubricating portions of the sliding portions of the multi-plate friction clutch, the gear transmission M and the like and thereafter returns to the oil pan 10. Meanwhile, the oil which has lubricated the drive gear 18, the intermediate gears 19 and the two timing gear trains 20 and 21, returns from the lower portion of the gear chamber 23 opened to the oil pan 10 to the oil pan 10 and the lubricating oil supplied to the front valve operating chamber 52F, returns to the oil pan 10 via the return oil paths 55 through 57 and the return pipe 58 and the lubricating oil supplied to the rear valve operating chamber 52R returns to the oil pan 10 via the return oil paths 72 and 68 and via the transmission chamber 9. In this way, the lubricating oil supplied into the crankcase 8 is sucked by the first through the third scavenge pumps 37 through 39 and therefore, there is hardly caused power loss by scraping up the lubricating oil by the crankshaft 7.

[0053] Further, as described above, blowby gas in the crankcase 8 is sucked to the first through third scavenge pumps 37 through 39 along with the lubricating oil, discharged into the transmission chamber 9 and recirculated from the transmission chamber 9 to the intake path by way of the breather path 67 formed at the space portion 60, the breather path 71 formed at the space portion 70, the rear valve operating chamber 52R, the breather chamber 74 and the recirculating pipe, supplied to the combustion chamber and combusted.

[0054] Here, in the rear bank 4R, the space portion 60 formed between the cylinder bore B2 and the cylinder bore B4 at the position opposed to the cylinder bore B3 of the front bank 4F, is provided with the width in the direction of the rotational axis line L to a degree slightly smaller than the diameter of the cylinder bore B3 at the minimum within a range not projected in the direction of the rotational axis line L relative to the front bank 4F and therefore, there is provided the breather path 67 having the sufficiently large flow path area without increasing the width in the direction of the rotational axis line L of the rear bank 4R having a number of cylinders smaller than that of the front bank 4F, and the width in the orthogonal direction and accordingly, without increasing the width in the direction of the rotational axis line L of the cylinder block 1, without deteriorating the advantage of the cylinder block 1 downsized by reducing the width in the direction of the rotational axis line L by coupling the two connecting rods R1 and R2 and the two connecting rods R4 and R5 respectively to the two crankpins K1 and K3 and after reducing the weight of the cylinder block 1. Further, by increasing the flow path area of the breather path 67, a flow rate of the blowby gas flowing in the breather path 67 is restrained to be low and therefore, there is expedited an effect of separating

lubricating oil mist mixed in the blowby gas.

[0055] The space portion 60 is provided with the width in the direction of the rotational axis line L to the degree slightly smaller than the diameter of the cylinder bore B3 within the range not projected to the front bank 4F in the direction of the rotational axis line L and therefore, the return oil path 68 of the lubricating oil having the sufficiently large flow path area can be formed other than the breather path 67 having the sufficient flow path area without enlarging the cylinder block 1, the lubricating oil from the rear valve operating chamber 52R returns smoothly, the blowby gas and the lubricating oil can be restrained from being mixed with each other by the partition wall 61 partitioning the two paths 64 and 65 in parallel with the direction of the rotational axis line L and an amount of the lubricating oil mist mixed into the blowby gas can be reduced also in this regard.

[0056] By separating the crankcase 8 and the transmission chamber 9 by the partition wall comprising the upper partition wall A1 and the lower partition wall A2, the breather path 67 constituted by the opening portion 63, the path 66 and the path 64 is also separated from the crankcase 8 and the therefore, the lubricating oil scattered by rotating the crankshaft 7 does not directly intrude the breather path 67 and the lubricating oil mist is prevented from mixing to the blowby gas.

[0057] The partition wall 61 and the partition wall 73 are respectively formed with the water paths 61a and 73a of cooling water and therefore, in warming up the internal combustion engine E, the breather paths 67 and 71 are warmed by cooling water of the cooling water jackets of the cylinder block 1 and the rear cylinder head 2R as well as cooling water flowing in the water paths 61a and 73a of the partition walls 61 and 73, condensation of steam at the breather paths 67 and 71 and the breather chamber 74 is prevented and accordingly, water is prevented from mixing to the separated lubricating oil and a deterioration of the lubricating oil caused by mixing water can be avoided.

[0058] Further, at the upper portion of the partition wall 61, there are constituted the eaves portion 61b extended to the outer side of the V-bank and the projected edge portion 61c constituting the front end portion of the eaves portion 61b and therefore, although a portion of the blowby gas flowed from the opening portion 63 reaches the rear valve operating chamber 52R by passing through the return oil paths 68 and 72, a portion thereof impinges on the side face 61d of the partition wall 61 on the side of the return oil path 68 and an elevating flow is produced along the side face 61d, the elevating blowby gas impinges on the lower face of the eaves portion 61b and the elevating flow is hampered and deflected to the lower side by the projected edge portion 61c and therefore, the flow of the lubricating oil passing through the return oil path 68 is significantly restrained from being hampered by the elevating blowby gas and the lubricating oil flows down to the return oil path 68 smoothly.

[0059] Further, the attaching face 45a of the attaching seat 45 formed at the front wall 6c of the lower crankcase 6, is disposed above the lower end face 6b coupled with the oil pan 10 of the lower crankcase 6 and is disposed at a position comparatively higher than that in the case of attaching the oil filter 44 to the oil pan 10 or the case of arranging the oil filter 44 to ride over the lower crankcase 6 and the oil pan 10 and further, the oil filter 44 is formed forward from the assumed plane H and substantially along the assumed plane H and therefore, regardless of presence of the curved wall portion 6c1 bulged forwardly, the attaching face 45a can easily be recognized from above and therefore, attachment and detachment of the oil filter 44 while confirming the attaching face 45a are facilitated and the operability of maintenance of the oil filter 44 is promoted. Further, by disposing the attaching face 45a rearward from the contact portion 6c3 in contact with the assumed plane H on the front side of the curved wall portion 6c1 bulged to the front side of the front wall 6c of the lower crankcase 6, an amount of projecting the oil filter 44 to the front side is restrained and therefore, the internal combustion engine E can be downsized and there is increased a degree of freedom of arranging an exhaust pipe connected to the exhaust port 13, extended to the lower side by passing through the front side of the front bank 4F, bent to the left side at the lower side and extended through the space formed to recess the lower portion of the left wall of the oil pan 10 to the right side in the lower direction.

[0060] Further, the attaching seat 45 is provided by utilizing the space formed between the front face of the curved wall portion 6c1 and the front face of the flat wall portion 6c2, further, the introducing oil path G4 and the introducing oil path G5 are formed at inside thereof and therefore, it is not necessary to project the front wall 6c of the lower crankcase 6 into the crankcase 8 for forming the oil paths G4 and G5, the inner structure of the crankcase 8 can be simplified, the crankcase can be downsized and accordingly, the internal combustion engine E can be downsized. Furthermore, the introducing path G5 formed at a position more remote in the direction orthogonal to the attaching face 45a from the attaching face 45a directed in the skewed lower direction than the introducing oil path G4, is formed at a vicinity of the lower end portion 6c1a constituting a corner portion formed by the curved wall portion 6c1 and the flat wall portion 6c2 and therefore, the inside of the attaching seat 45 can effectively be utilized, an amount of projecting the attaching seat 45 to the front side is reduced and accordingly, an amount of projecting the oil filter 44 to the front side is reduced and the internal combustion engine E can further be downsized.

[0061] An explanation will be given of a modified constitution with regard to an embodiment modifying a portion of the constitution of the above-described embodiment as follows.

[0062] Although according to the embodiment, the in-

ternal combustion engine E is provided with the hermetically closed crankcase 8, the breather apparatus may communicate with the breather path 67 via a path communicating with the crankcase without hermetically closing the crankcase and in that case air downstream from an air cleaner of the intake system is introduced into the front valve operating chamber communicating with the crankcase via the path. Further, a PCV valve can be provided at the breather chamber or the output pipe.

[0063] Although according to the embodiment, the V-type internal combustion engine E is constituted by 5 cylinders, the internal combustion engine E may be a V-type internal combustion engine having an odd number of cylinders, for example, may be an internal combustion engine of 3 cylinders or 7 cylinders. Further, in the case of a 3-cylinder V-type internal combustion engine, the space portion of the cylinder block is formed at a position contiguous to a cylinder bore of a bank having an odd number of the cylinder comprising 1 cylinder and by a width in a rotational axis line direction which is not projected in the rotational axis line direction of a crankshaft relative to a bank having an even number of cylinders comprising 2 cylinders constituting a bank having a larger number of cylinders.

[0064] Further, although according to the above-described embodiment, the first and the third crankpins K1 and K3 are respectively connected with two of the connecting rods R1 and R2 and two of the connecting rods R4 and R5, there may be constituted a V-type internal combustion engine of a style of connecting a single connecting rod to respective crankpin, further, there may be constituted a V-type internal combustion engine of a style in which crankpins each connected with two connecting rods and crankpins each connected with a single connecting rod are irregularly present in a rotational axis line direction of a crankshaft.

[0065] Further, although the two space portions 60 and 70 are formed with the two paths 64 and 65 respectively divided by the two partition walls 61 and 73, the breather path 71 and the return oil path 72, there may be formed a single path having an opening portion of an area equal to or larger than an area combined with the areas of the opening portions 64a and 65a of the two paths 64 and 65 without providing the two partition walls 61 and 70 and the path may serve as the breather path and the return oil path. Further, the breather path and the return oil path may be formed only by the partition wall 61 without providing the partition wall 73.

[0066] In summary it is an object to provide a V-type internal combustion engine capable of forming a breather path having a sufficiently large flow path area without enlarging a cylinder block.

[0067] To achieve this, a 5-cylinder V-type internal combustion engine includes a breather apparatus, a crankshaft having three crankpins and a cylinder block 1 formed with a front bank 4F of three cylinders and a rear bank 4R of two cylinders. Each of two crankpins disposed at both ends is connected with both of two connecting rods connected to pistons fitted to cylinder bores formed in the front and the rear banks 4F and 4R, a crankpin disposed at a middle is connected only with a connecting rod connected to a piston fitted to a cylinder bore B3 formed at a middle of the front bank 4F and in the rear bank 4R, a breather path 67 of a breather apparatus is formed at a space portion 60 between the two cylinder bores at a position opposed to the cylinder bore B3 at the middle.

Claims

1. A V-type internal combustion engine **characterized in that** in a V-type internal combustion engine (E) including a breather apparatus for recirculating blowby gas from a crankcase (8) to an intake system (12), a crankshaft (7) having three or more of crankpins (K1, K2, K3) including a first, a second and a third crankpin (K1, K2, K3) contiguous to each other in a direction of a rotational axis line and a cylinder block (1) formed with a first and a second bank (4R, 4F) forming a V-like shape; the first and the third crankpins (K1, K3) are respectively connected with a first and a third connecting rod (R2, R4) respectively connected to a first and a third piston (P2, P4) respectively fitted to a first and a third cylinder bore (B2, B4) formed at the first bank (4R), the second crankpin (K2) disposed between the first and the third crankpins (K1, K3), is connected only with a second connecting rod (R3) connected to a second piston (P3) fitted to a second cylinder bore (B3) formed at the second bank (4F) and the breather apparatus includes a breather path (67) formed at a space portion (60) between the first and the third cylinder bores (B2, B4) in the first bank (4R).

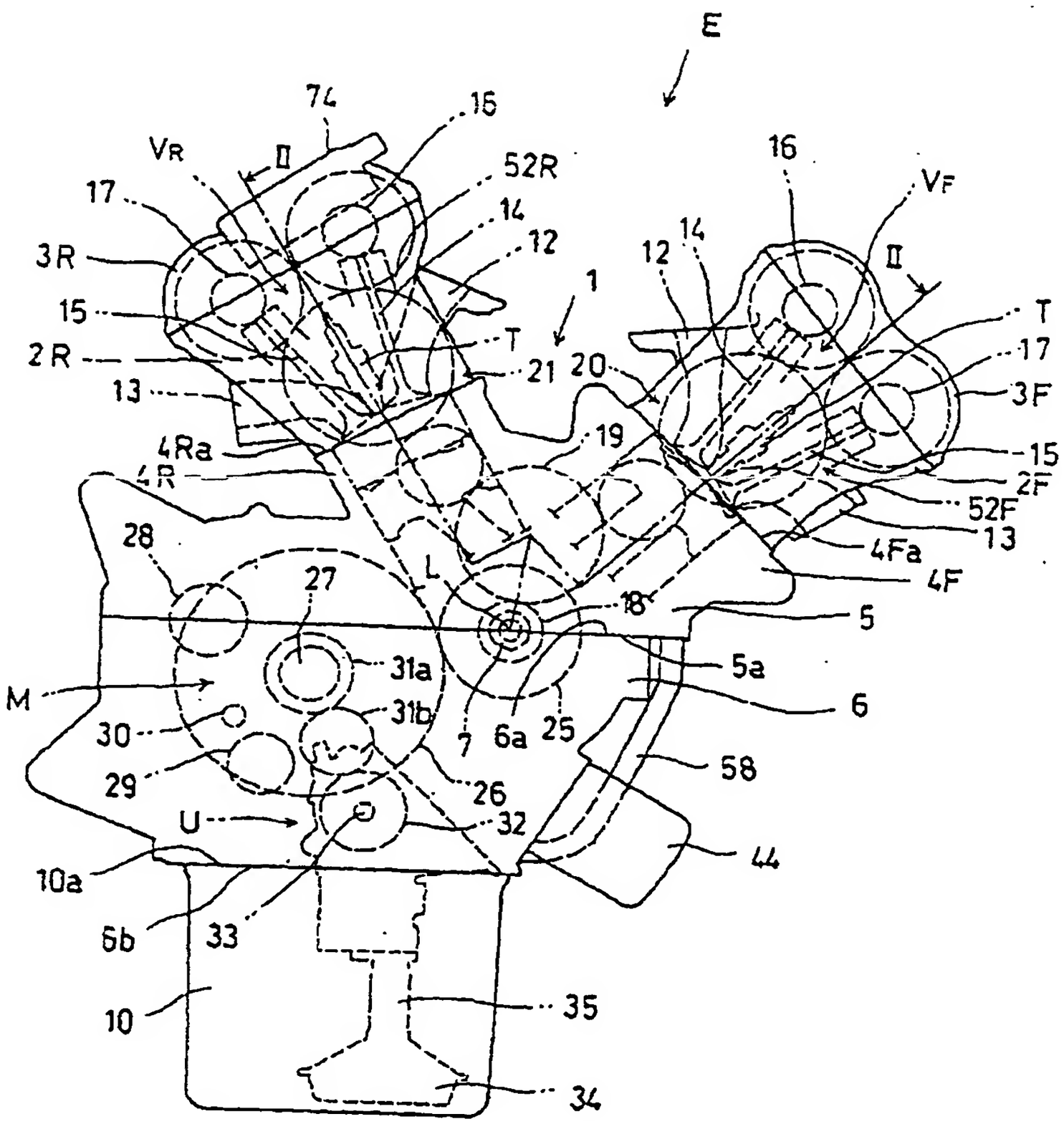
2. A V-type internal combustion engine **characterized in that** in a V-type internal combustion engine (E) of an odd number of cylinders (C1 - C5) including a breather apparatus for recirculating blowby gas from a crankcase (8) to an intake system (12), a crankshaft (7) having a plurality of crankpins (K1, K2, K3) including a first and a second crankpin (K1, K2) contiguous to each other in adirection of a rotational axis line and a cylinder block (1) formed with a first bank (4F) having an odd number of cylinders (C1, C3, C5) and a second bank (4R) having an even number of cylinders (C2, C4) forming a V-like shape; the first crankpin (K1) is connected with both of a first and a second connecting rod (R1, R2) respectively connected to a first and a second piston (P1, P2) respectively fitted to a first and a second cylinder bore (B1, B2) respectively formed at the first and the second banks (4F, 4R), the second crankpin (K2) is connected only with a third connecting rod (R3) connected to a third piston (P3) fit-

ted to a third cylinder bore (B3) formed at a bank in (4F) the first and the second banks (4F, 4R) having a larger number of the cylinders (C1, C3, C5) and the breather apparatus includes a breather path (67) formed at a space portion (60) contiguous to a side the same as a side at which the second crankpin (K2) is contiguous to the first crankpin (K1) relative to the first cylinder bore (B1) or the second cylinder bore (B2) in a bank (4R) of the first and the second banks (4F, 4R) having a smaller number of the cylinders (C2, C4).

3. The V-type internal combustion engine according to Claim 2, **characterized in that** the crankshaft (7) includes a third crankpin (K3) contiguous to a side opposed to the side at which the first crankpin (K1) contiguous to the second crankpin (K2), wherein the third crankpin (K3) is connected with both of a fourth and a fifth connecting rod (R4, R5) respectively connected to a fourth and a fifth piston (P4, P5) respectively connected to a fourth and fifth cylinder bore (B4, B5) respectively formed at the first and the second banks (4F, 4R) and the space portion (60) is present between the first and the fourth cylinder bores (B1, B4) or between the second and the fifth cylinder bores (B2, B5).

4. The V-type internal combustion engine according to any one of Claim 1 through Claim 3, **characterized in that** the space portion (60) is formed with a return oil path (68) of lubricating oil and a partition wall (61) is provided between the breather path (67) and the return oil path (68) for partitioning such that the breather path (67) and the return oil path (68) are in parallel with each other in the direction of the rotational axis line.

FIG. 1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VR
II
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14
12
3R
15
2R
13
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4R
1
T
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16
VF
12
14
II
T
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3F
15
2F
52F
13
4Fa
4F
28
27
L
18
5
5a
6
31a
M
31b
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6a
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6b
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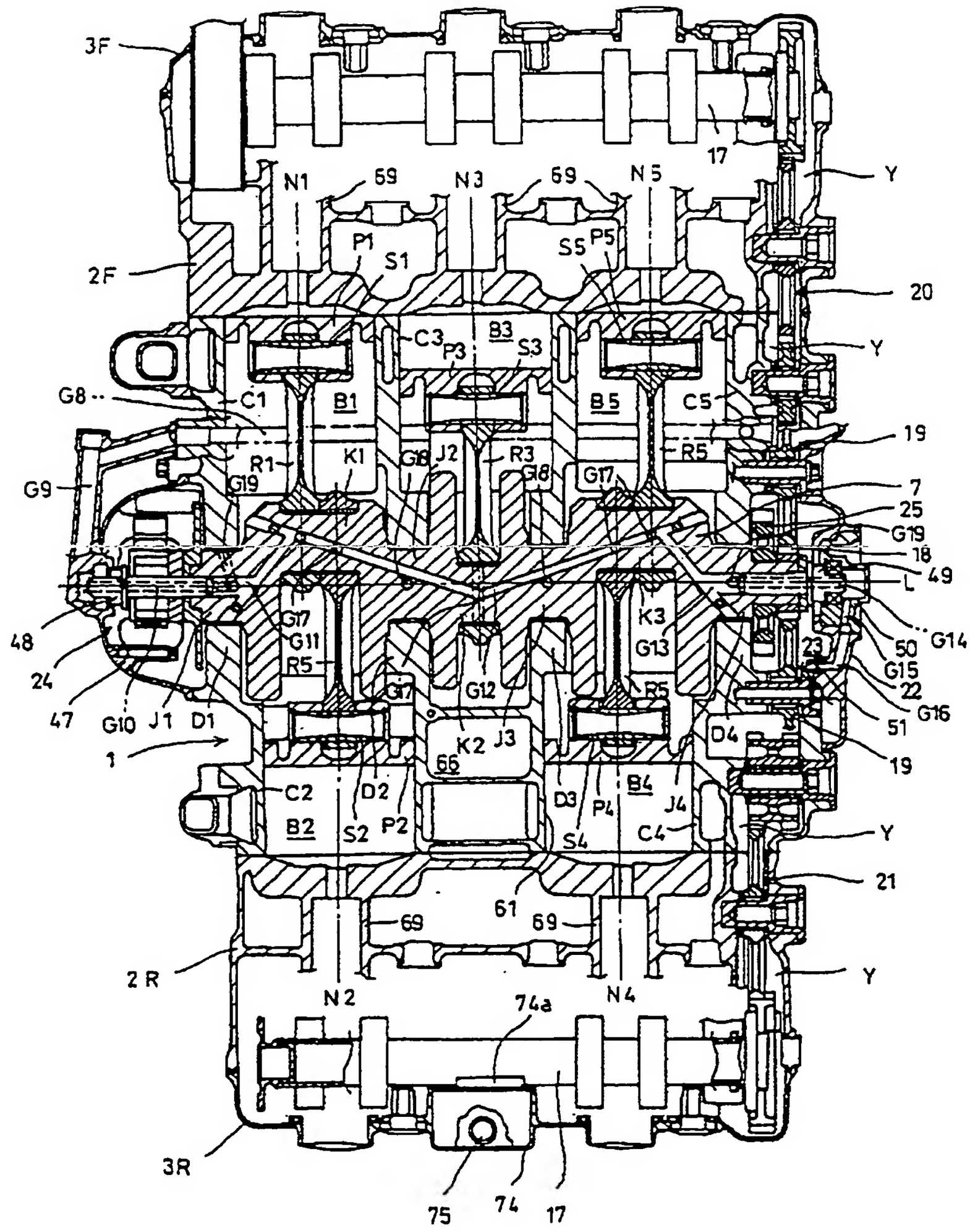
35
34

FIG. 2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N3
69
N5
17
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P1
S1
S5
P5
2F
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C3
P3
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S3
Y
G8
C1
B1
B5
C5
19
R1
K1
G8
J2
R3
G8
G17
R5
G9
G19
7
25
G19
18
49
L
48
G17
G11
R5
K3
G13
23
50
G14
24
G15
22
47
G10
J1
D1
G17
G12
R5
G16
51
K2
J3
D4
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66
19
C2
D2
D3
P4
B4
J4
B2
S2
P2
S4
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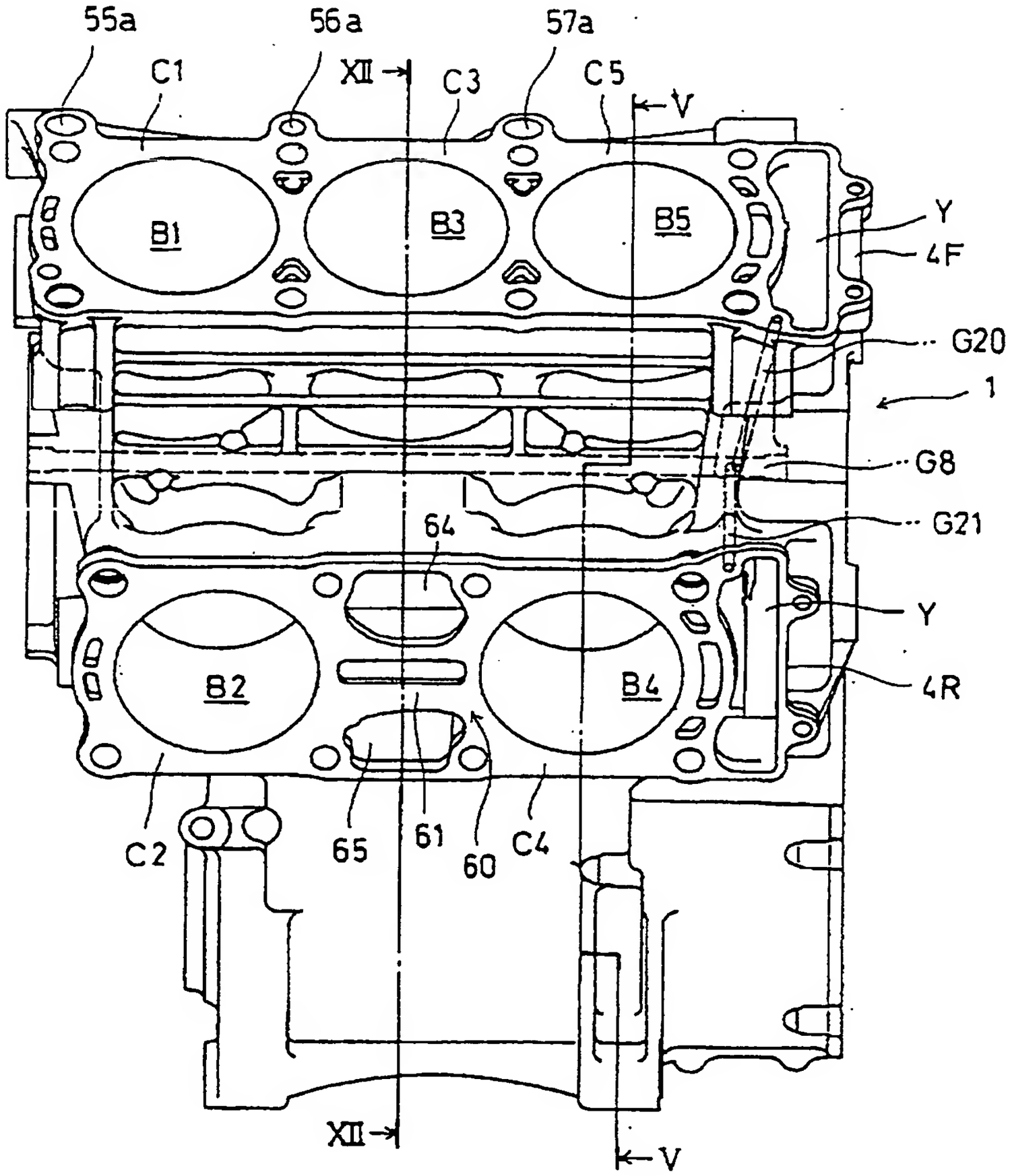
69
2R
Y
N2
74a
N4
3R
75
74
17

FIG. 3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56a
57a
C1
XII
C3
C5
V
B1
B3
B5
Y
4F
G20
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G8
G21
64
Y
B2
B4
4R
C2
65
61
60
C4
XII
V

FIG. 4

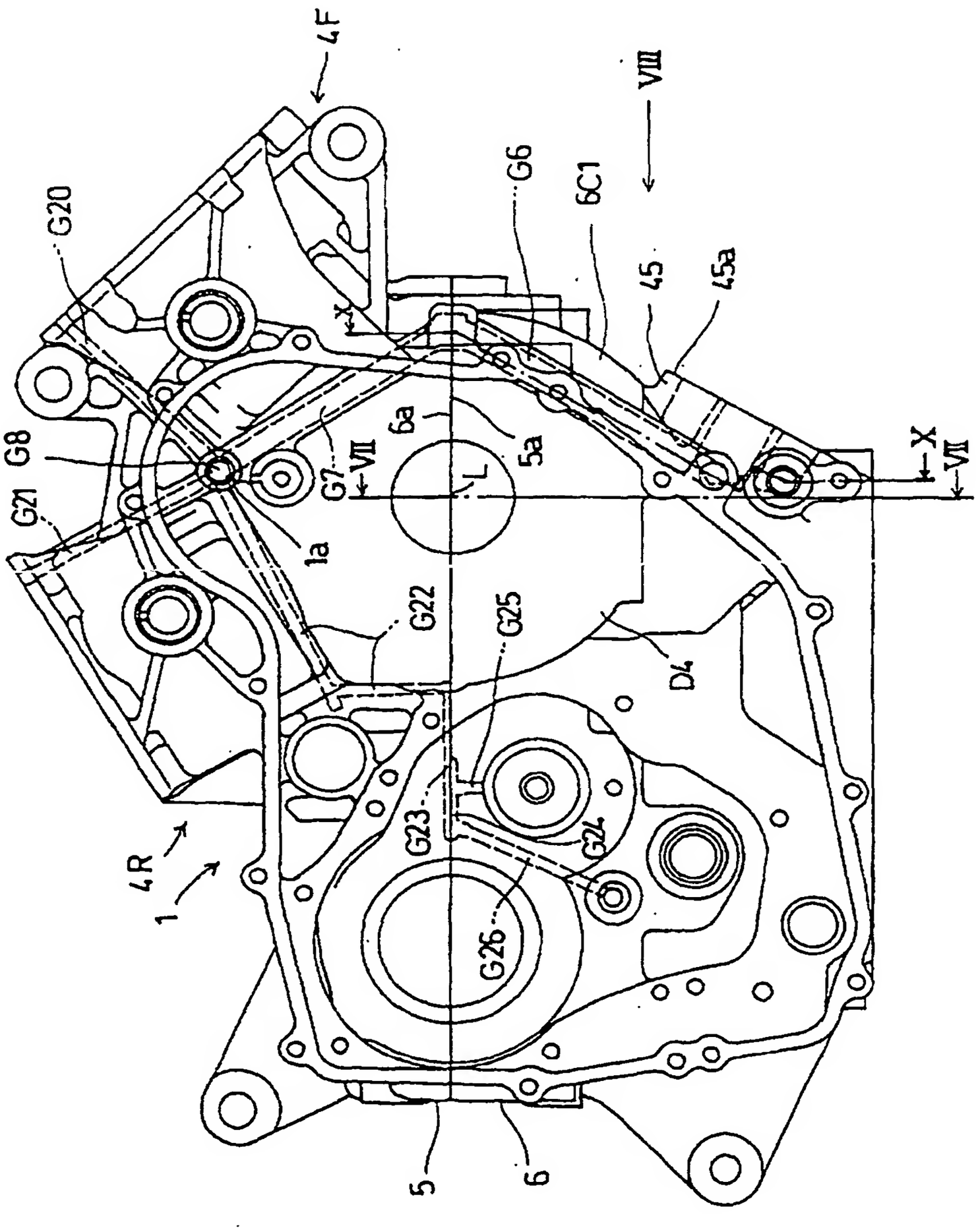

4F
VIII
G20
G6
6C1
45
45a
X
VII
G8
G7
VII
6a
5a
L
G21
1a
G22
G25
D4
G23
G24
G26
4R
1
5
6

FIG. 5

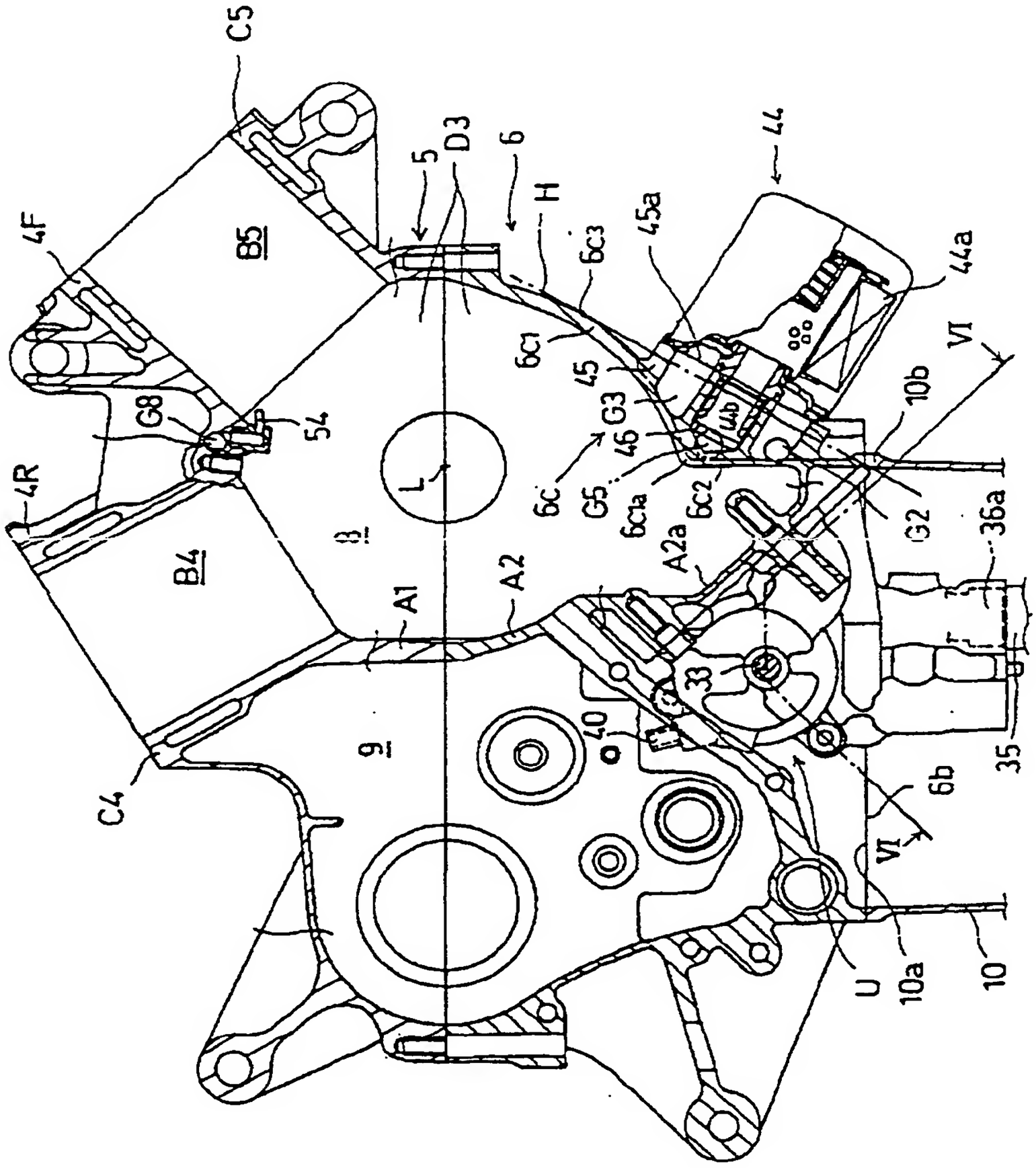

C5
5
D3
6
H
44
4F
B5
45a
44a
6c3
6c1
45
VI
G8
54
G3
10b
4R
L
6c
46
G5
6c1a
6c2
G2
36a
B4
B1
A1
A2
A2a
33
40
9
C4
35
6b
VI
U
10a
10

FIG. 6

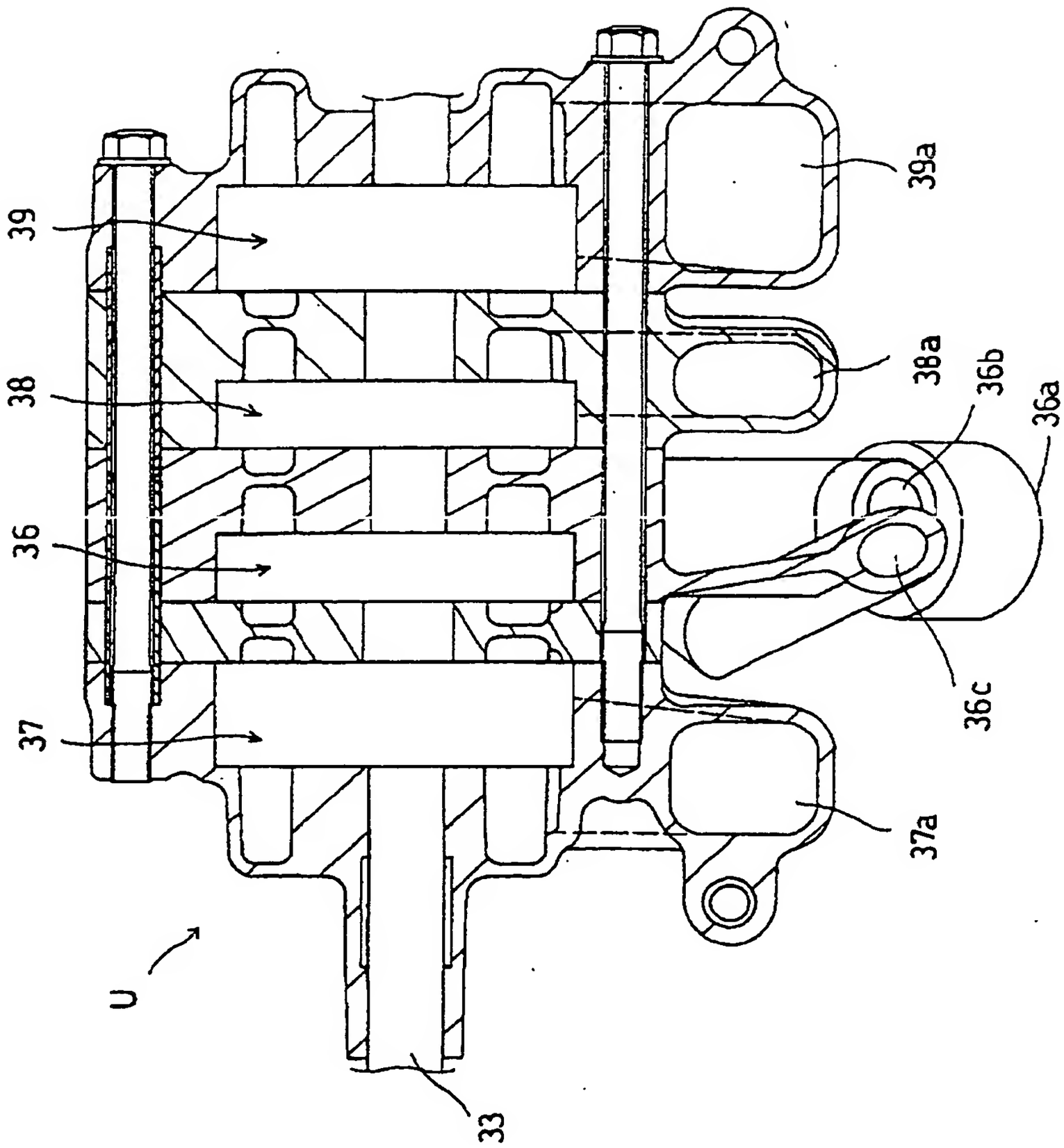


FIG. 7

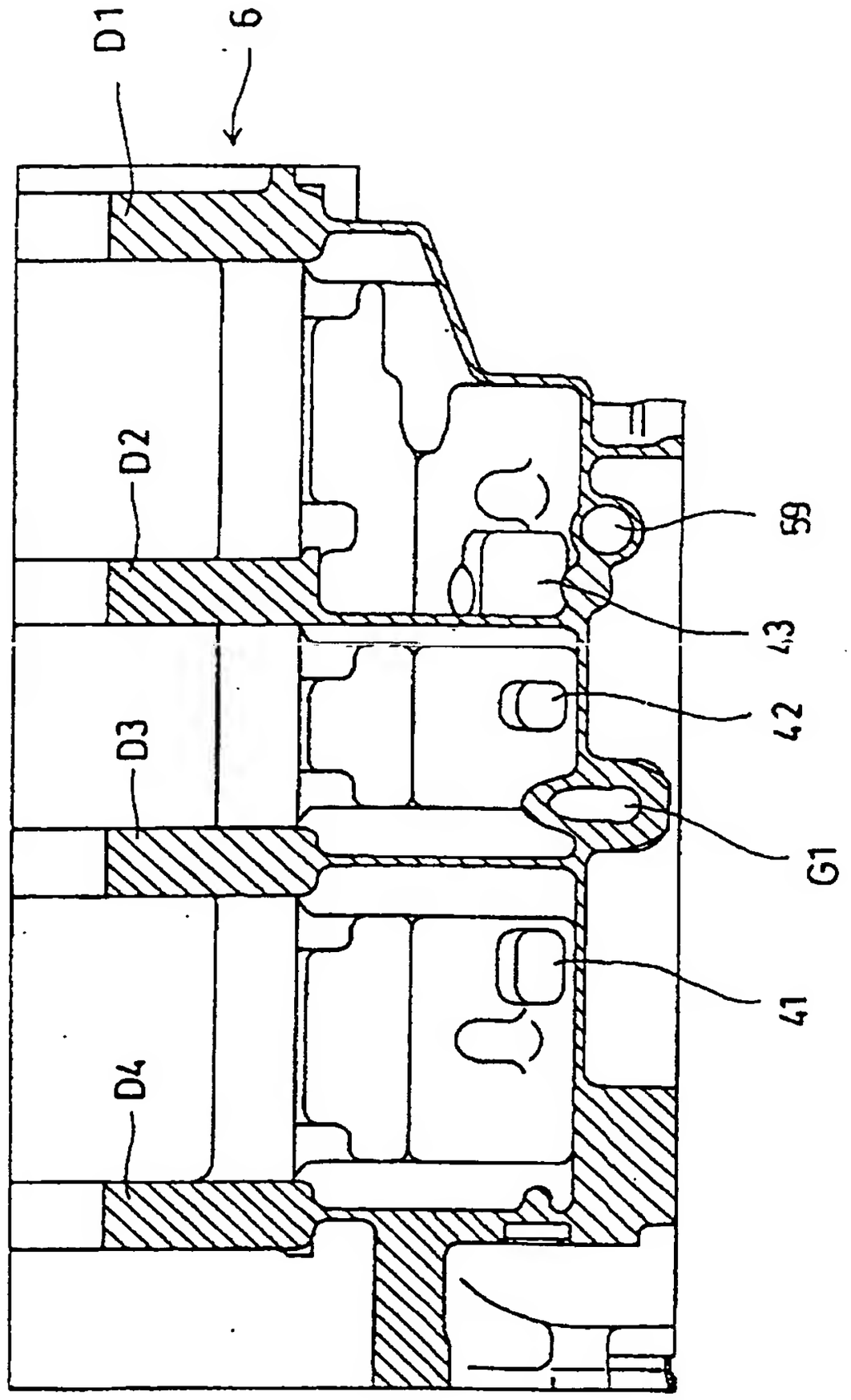


FIG. 8

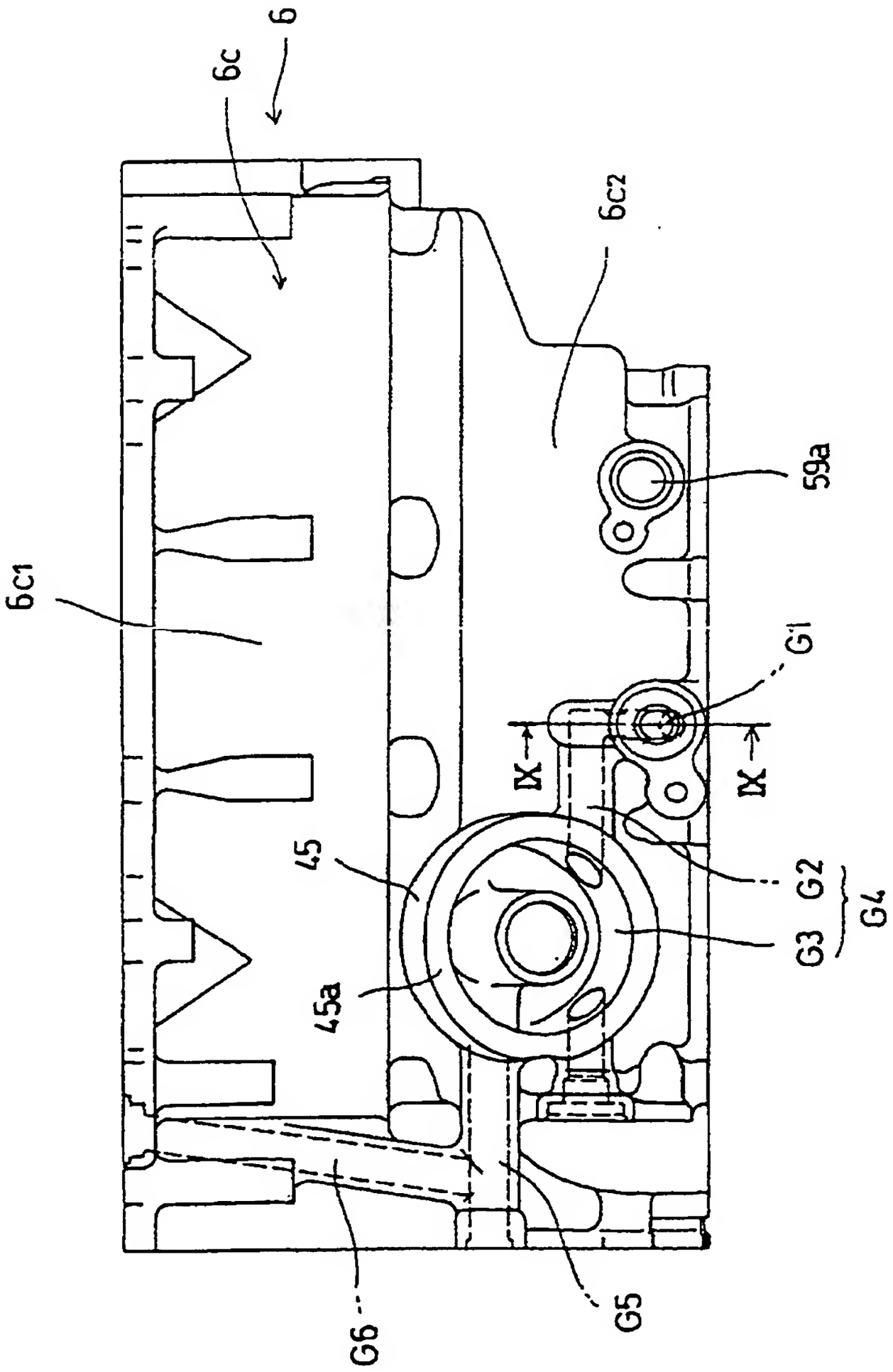


FIG. 9

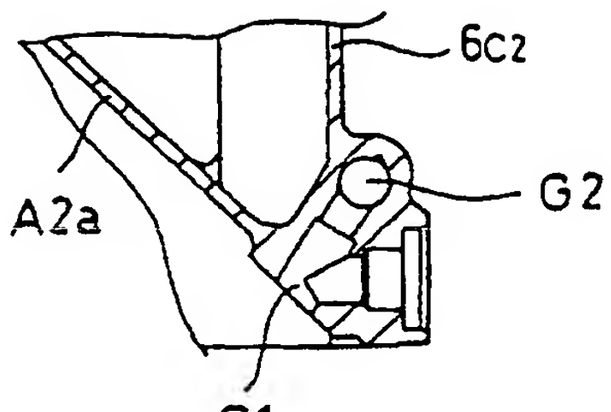


FIG. 10

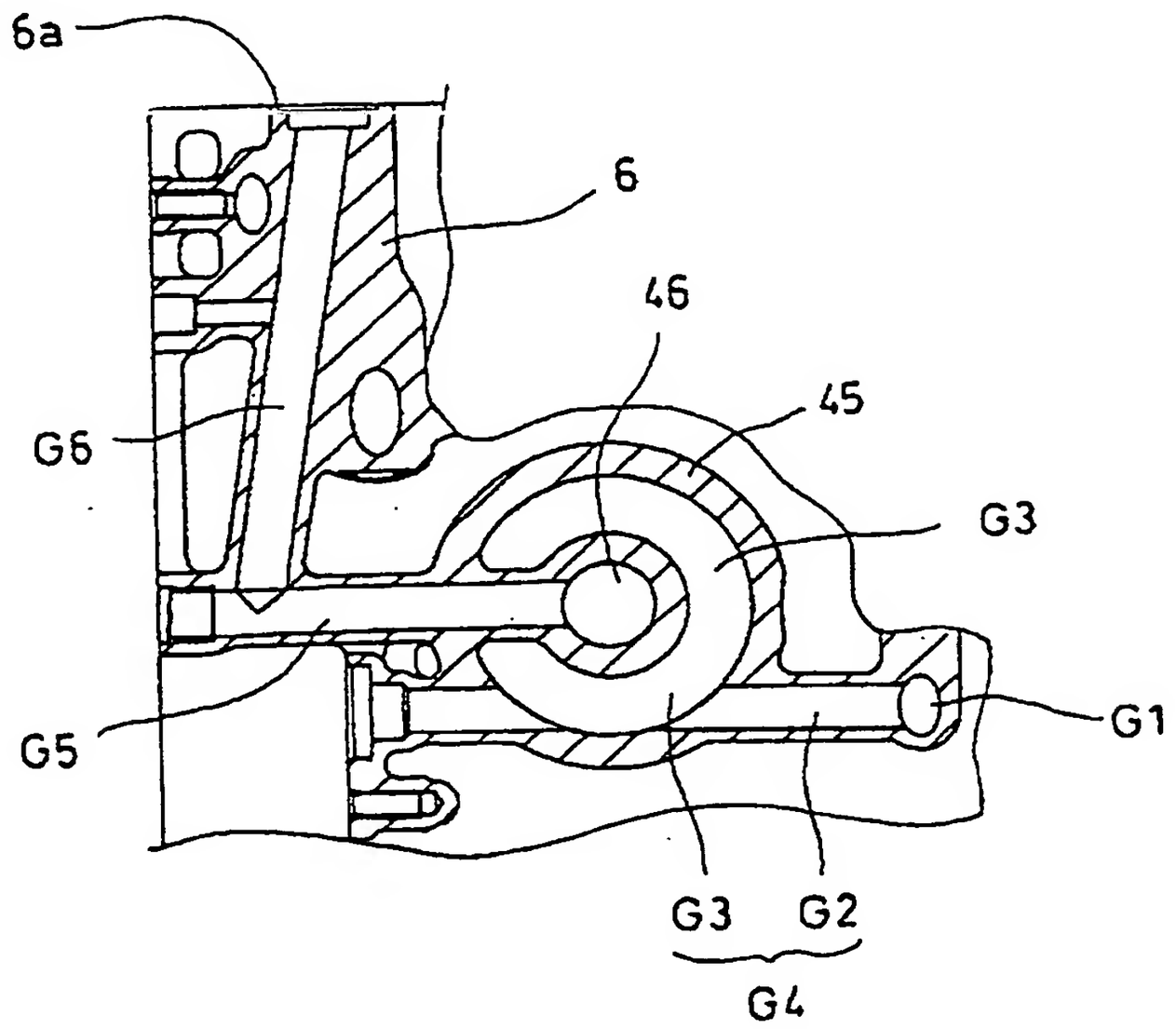
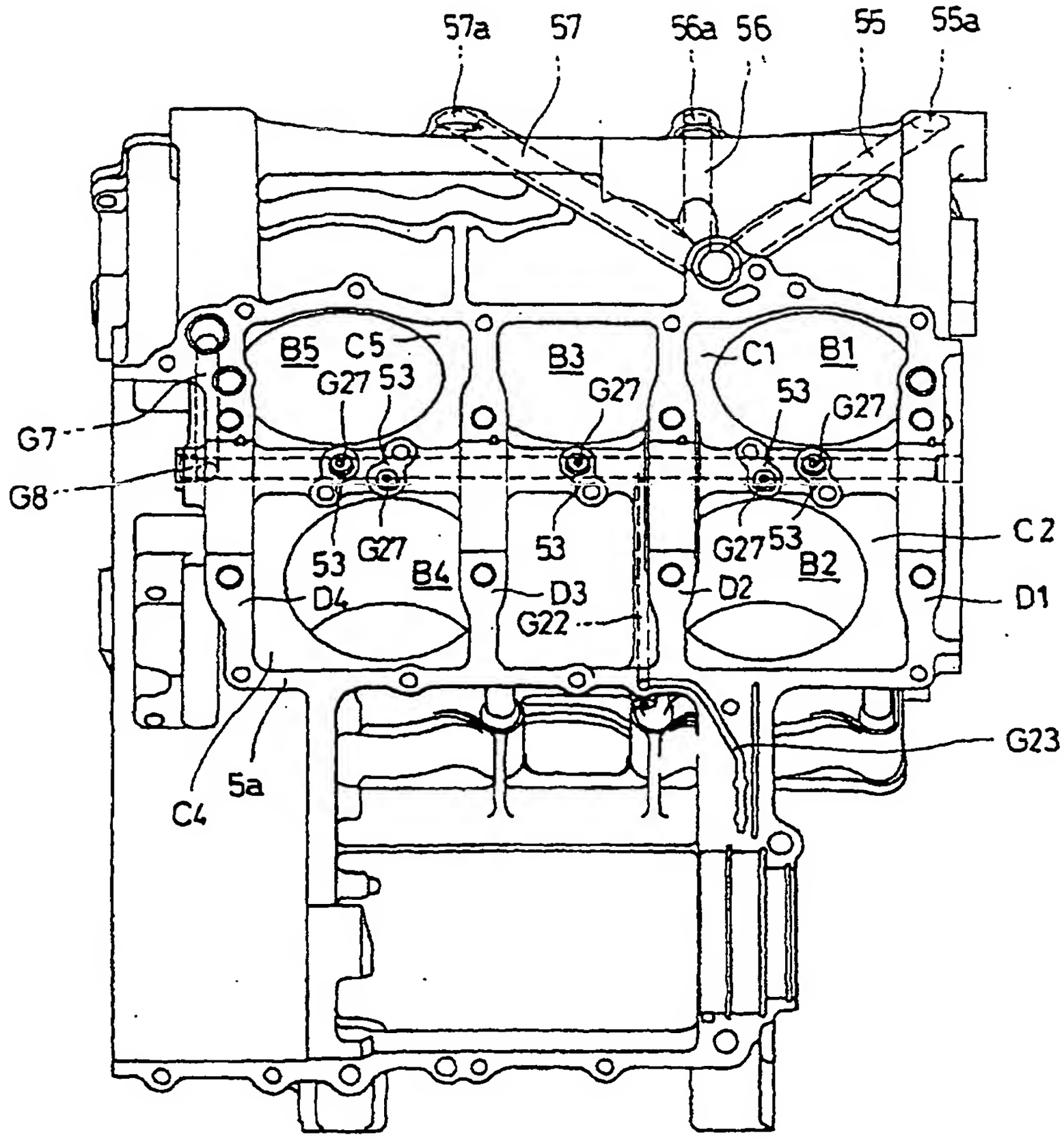


FIG. 11


57a
57
56a
56
55
55a
B5
C5
G27
53
B3
G27
C1
B1
53
G27
G7
G8
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D3
D2
D1
G22
G23
C4
5a

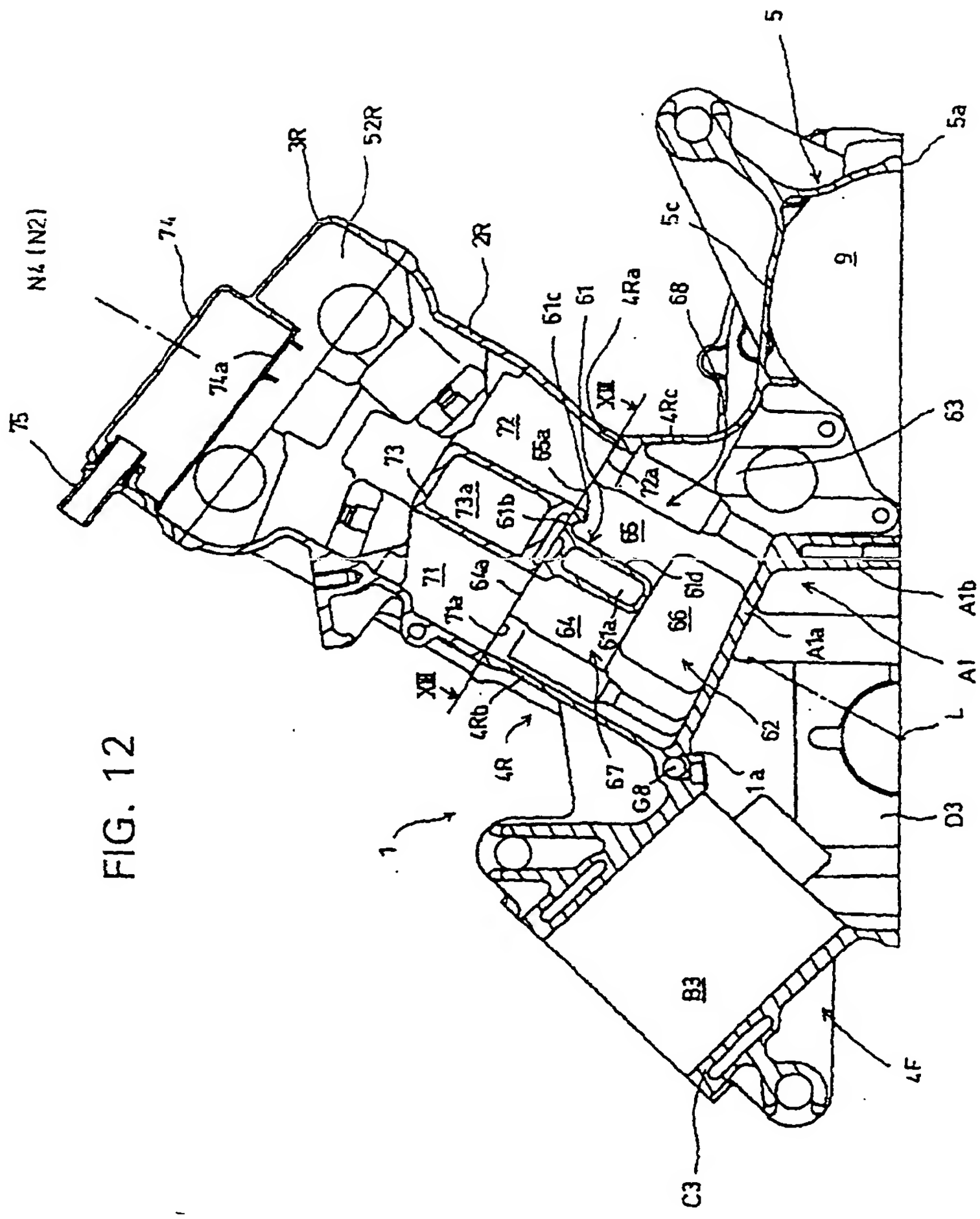

5
5a
5c
9
3R
52R
2R
N4 (N2)
74
74a
75
73
72
73a
61b
61c
61
4Ra
68
XII
4Rc
63
65a
72a
65
71
71a
64a
64
61a
61d
66
A1b
A1a
A1
L
62
67
G8
1a
D3
4Rb
4R
1
B3
4F
C3

FIG. 12

FIG. 13

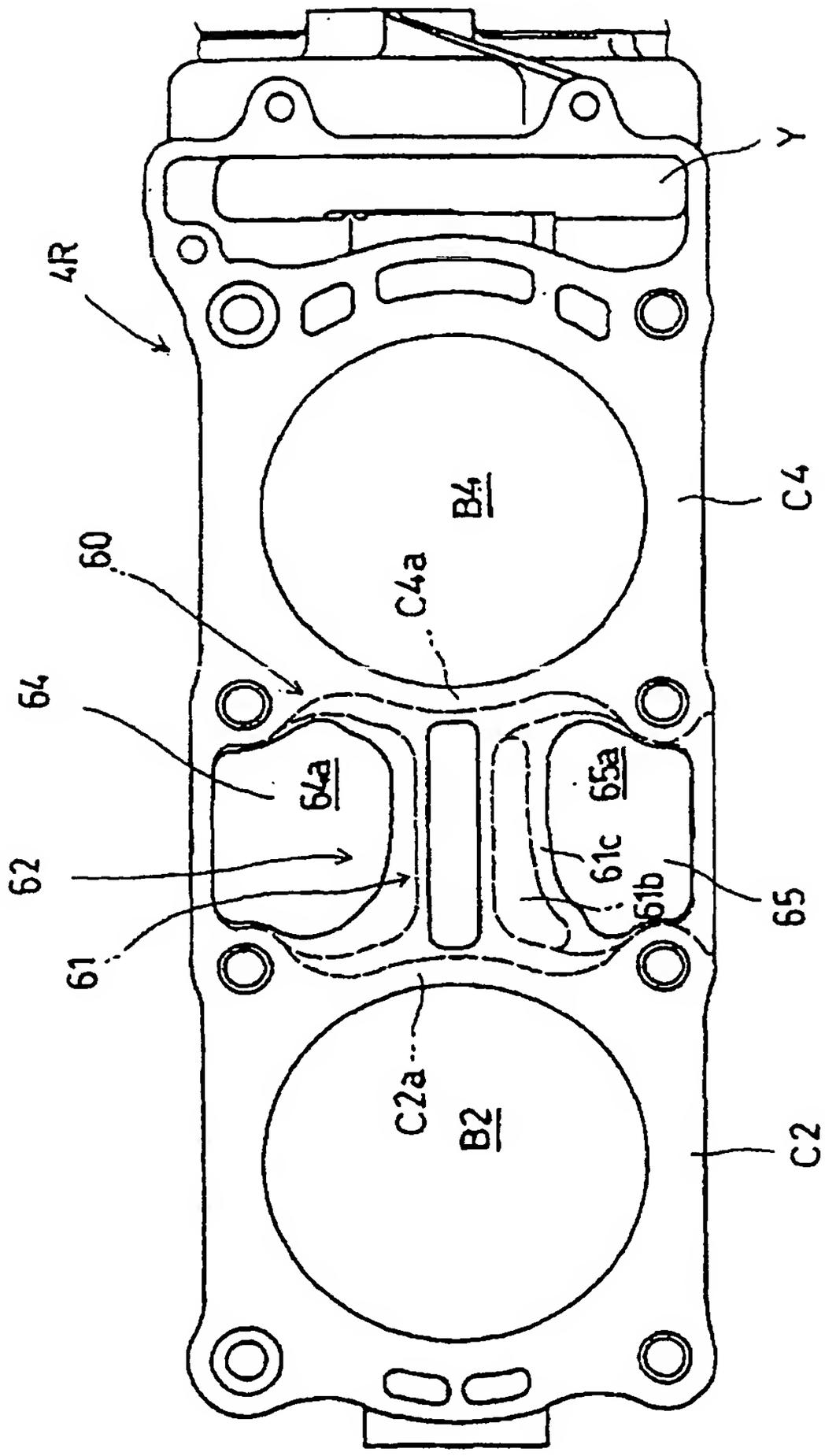
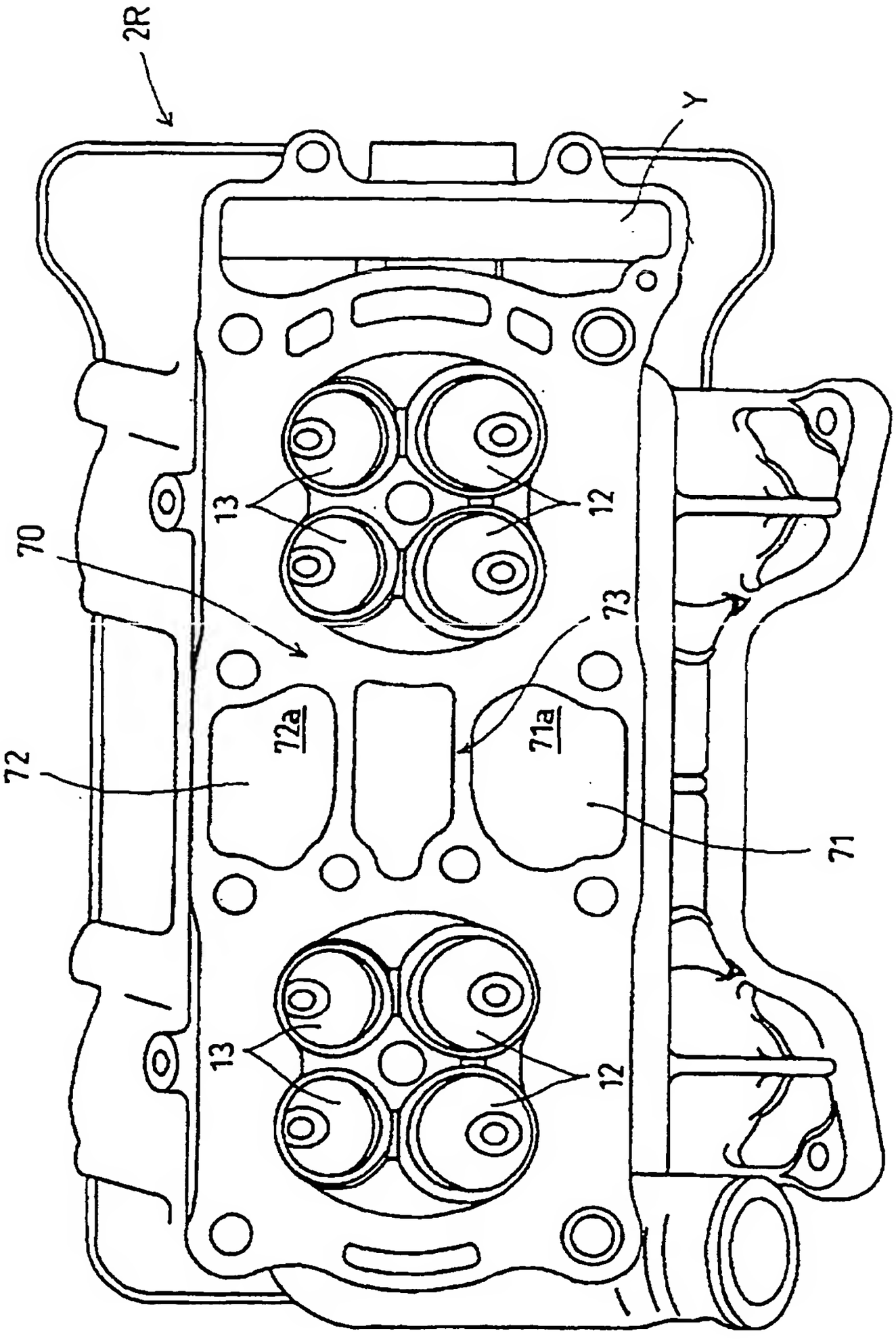


FIG. 14



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EUROPEAN SEARCH REPORT

Application Number
EP 01 12 2371

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 March 2002	Mouton, J

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